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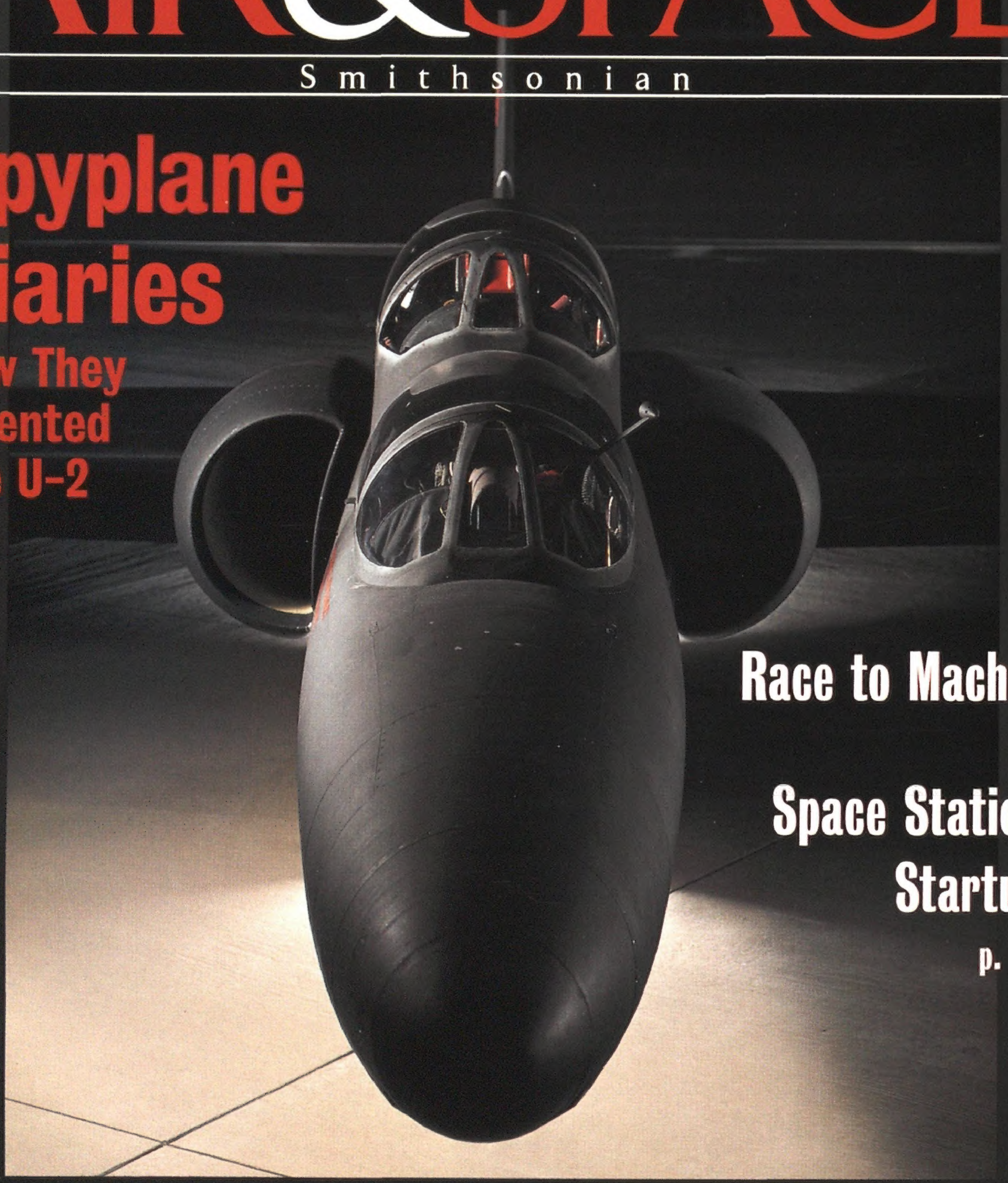

Race to Mach 1

Space Station Startup

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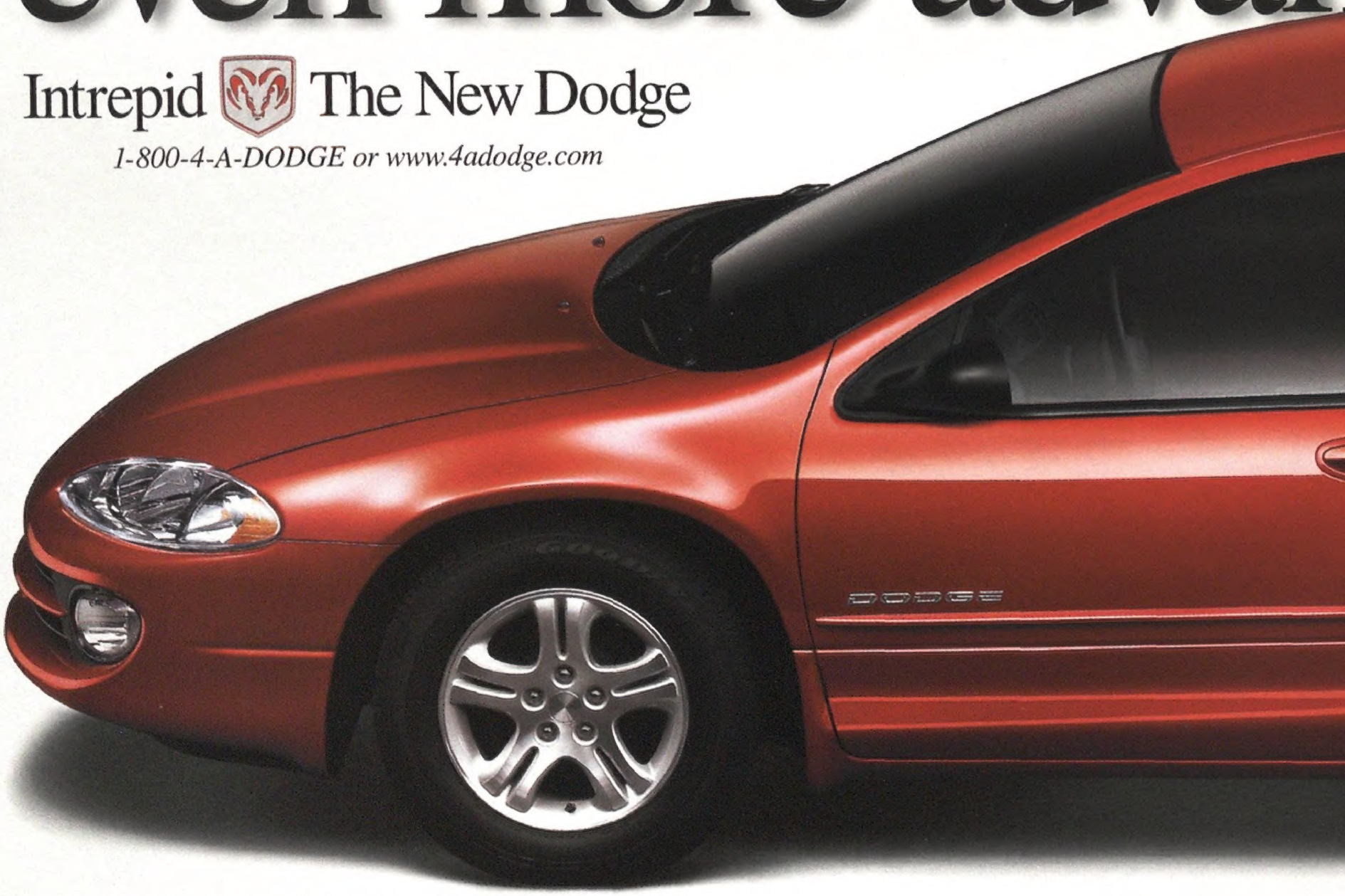

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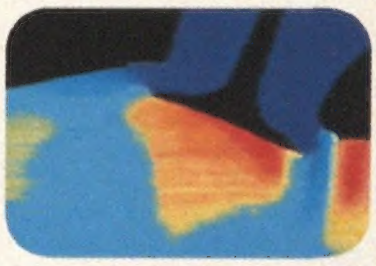

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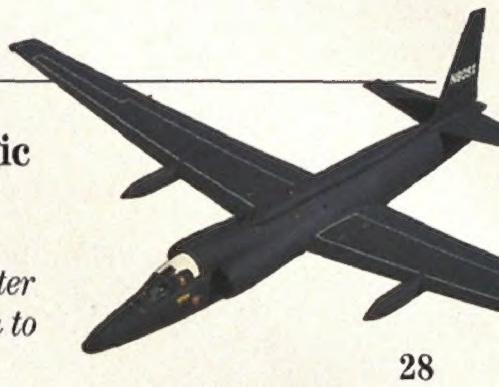

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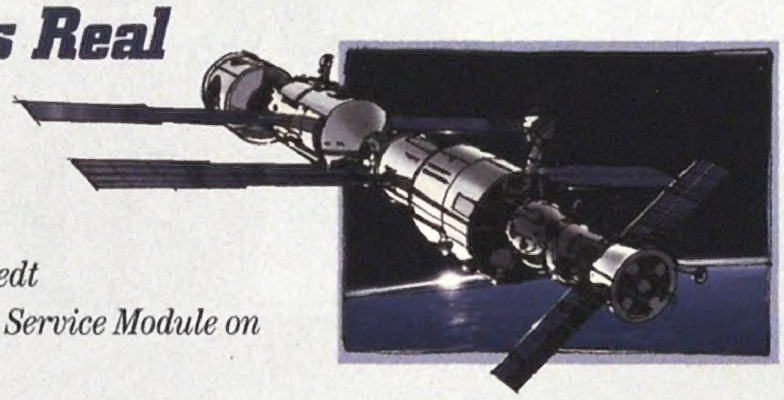
The International Space Station Gets Real



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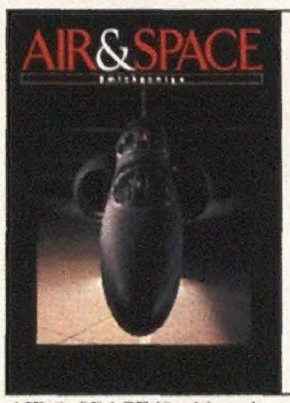

Cover:
Like any good spy, this two-seat U-2S(T) trainer hides in shadow. Photograph by Eric Schulzinger and Denny Lombard.

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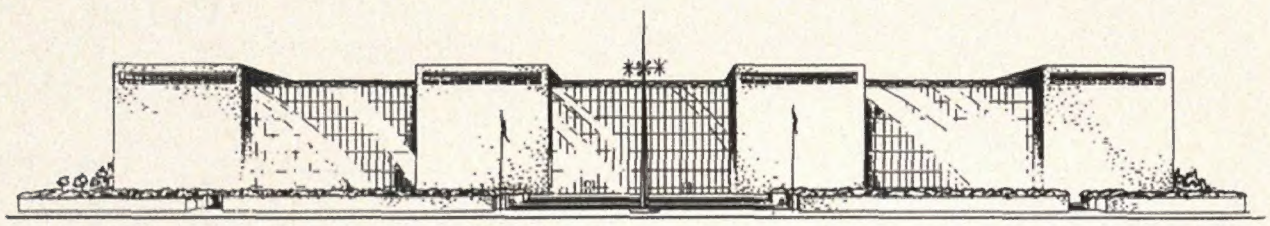

Our Goal for 2003

During the 1980s, while I was serving as the administrator of the Federal Aviation Administration, I became acutely aware of the plight of the Smithsonian Institution's National Air and Space Museum's collection. If it didn't get help, it was not going to be around for long. There was a clear need to replace the Garber facility in Maryland, where 70 percent of the collection was stored in less-than-adequate buildings. I proposed that the Museum lease unused land at the FAA's Dulles International Airport in Virginia to build a first-rate restoration and collection center.

I signed a lease agreement with Walter Boyne, the museum's director, in 1986. Years of Congressional debate about where such a facility should be located finally ended when it was resolved that Dulles International Airport would be the site. After leaving the FAA, I went on to other things and never dreamed that I might end up with the responsibility to *build* the Dulles Center. But here I am!

As director of the National Air and Space Museum for the past two years, I have seen the design for the Dulles Center through to completion. There was not enough federal money to pay for the design phase, so the Smithsonian Institution added the necessary funds. The Commonwealth of Virginia has committed to build the infrastructure—the entrance, the roads, and taxiways.

The Dulles Center will be a part of the National Air and Space Museum and will be located on the southeast corner of the airport property. It will provide 710,000 square feet of floor space, including a restoration center with two large hangars arranged side by side, each one big enough to hold airplanes as large as the *Enola Gay*. And there will be a taxiway connecting it to the airport.

The new center will have areas for archives and education. A Space Hall will house artifacts as large as the shuttle *Enterprise*. The Aircraft Hall is big enough to contain the entire museum on the Mall. There will be 185 aircraft of all kinds, some on the floor and others hung at two higher levels, that recount our conquest of the air. There will be a large-format theater with a restaurant on top, an observation tower with a lower deck for the study of air traffic control, and, of course, a museum shop and food courts.

This great building comes at a hefty price and must be funded by private capital from national foundations, industry, and individuals. We have started raising money, and we will announce the official launch of the capital campaign around mid-2000. But the challenge will not be met until the campaign is complete in 2003. The National Air and Space Society has been formed as a member organization to foster individual support. Key individuals are stepping forward to help lead the effort and raise the money. We will need many more leaders to make this great Dulles Center a reality.

We plan to start construction at the end of 2000. The facility will take 24 months to build. Our goal is to open this preeminent aerospace center in 2003, the centenary year of powered flight. You will learn more about the project in the days and months ahead.

Recently someone said to me, "Why are you doing this?" Obviously my age was showing, and he must have thought I should defer to it. I considered the question, and the answer came to me in the words of one of our early principal donors: "Because it is the 'Wright' thing to do."

—Don Engen is the director of the National Air and Space Museum.

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LETTERS

More Words on Warbirds

As an American, I am an "owner" of these vintage aircraft ("Whose Planes Are They, Anyway?," Oct./Nov. 1998), and I would much rather have a private party invest private funds to reclaim the aircraft, restore them, and put them into a private museum than let them continue to deteriorate in the ocean. Robert Neyland and Robert Rasmussen represent much of what is wrong with our government and military. They are part of a self-serving bureaucracy that is expensive to maintain and counterproductive to the *raison d'être* of the Naval Historical Center. These guys don't give a hoot about preserving anything but their jobs. Get rid of them!

—Thomas Hiniker
Lexington, Massachusetts

I wish to protest the use of the word "cowboys" in Doug Champlin's comment "We don't want a bunch of cowboys out there with grappling hooks...." I have been around real cowboys all of my life. To a man, they are honest, responsible people who do not take chances. Cowboys work hard, love their horses, and are proud of what they do. They deserve better than being equated with criminals.

—Jim Watts
Dallas, Texas

"Whose Planes Are They Anyway?" doesn't tell the whole story. After Robert Cervoni found an airplane off the coast of Florida, Douglas Aircraft historian Harry Gann urged him to send me a videotape of the airplane and get my opinion on the craft. I replied that it was a TBD and, based on my experience, restorable. I immediately added that the Navy and the National Museum of Naval Aviation claim ownership of all sunken Navy aircraft and that I had to notify the museum of his find.

Cervoni wondered whether the Navy would consider reimbursing him $25,000 for his time at the TBD site and holding a press conference with him to announce the discovery. I called Bob Rasmussen, told him about Cervoni's find, and arranged a meeting at Pensacola.

After viewing the tape and listening to Cervoni's request for a finder's fee,

"Granted, my client is a bird, Your Honor, but there is little risk of flight."

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Rasmussen said that he "saw no problem getting the money." I offered to put up the funds myself (I hoped my company would get to do the restoration), but Rasmussen said no, "This is exactly what the [museum's] foundation is for."

In the following weeks, I talked with Rasmussen, urging him to act quickly, as a secret like this could not be held for long. We decided to seek help from the Navy's elite Saturation Dive Team, which is equipped for long deep-water operations. I thought things were well on their way.

But then Cervoni called to say that Rasmussen would not return his calls. Cervoni also said that he had been contacted by someone who was willing to pay more than $25,000 for the wreck's location. Alarmed, I called Rasmussen. Now he seemed lukewarm about the TBD. His attitude was "I don't care whom he sells the location to, it's still our airplane." Cervoni called to say he'd given the museum a deadline, after which he would sell the information to the second party, Doug Champlin.

Champlin filed a salvage claim for the TBD in court. Although it's only hearsay, I was told that the museum called the court and got the location of the wreck from the claim. Soon afterward, A & T Recovery showed up in Miami and magically found the TBD after only a short search.

As for the infamous trade of the C-130s, if the foundation had sold those airplanes for what they are really worth, there'd have been millions left over. In any case, the trade took place two years ago and the TBD is still at the bottom of the ocean.

The whole fiasco has more twists and turns than a snake. The Navy and the museum ought to get out of Doug Champlin's way and let him get the job done.

—Roy Stafford
Fernandina Beach, Florida

Captain Robert Rasmussen responds: Although Mr. Stafford was involved in this matter with Mr. Cervoni early on, he had no direct part in decisions involving or discussions between the National Museum of Naval Aviation and Mr. Cervoni or Mr. Champlin, or in the museum's interactions with any other individual or agency. I will presume that Mr. Stafford's comments are based on his interpretation and recollection of events. However, the credibility of his assessments of my actions, including his direct quotations of me and his assessments of my attitude after six or seven years, should be questioned. His role in this transaction was peripheral and did not involve actions or decisions taken by the museum outside of the direct sphere of his company.

Mr. Stafford's offer to purchase the TBD's coordinates for the National Museum of Naval Aviation was turned down because it was not appropriate for me to accept an offer of assistance from a civilian contractor, especially one that contained some implied future consideration for contractual work. An offer with that kind of consideration must meet stringent requirements and be approved by the Secretary of the Navy. However, Mr. Stafford was still free to purchase the coordinates for his own purposes, just as Mr. Champlin did later.

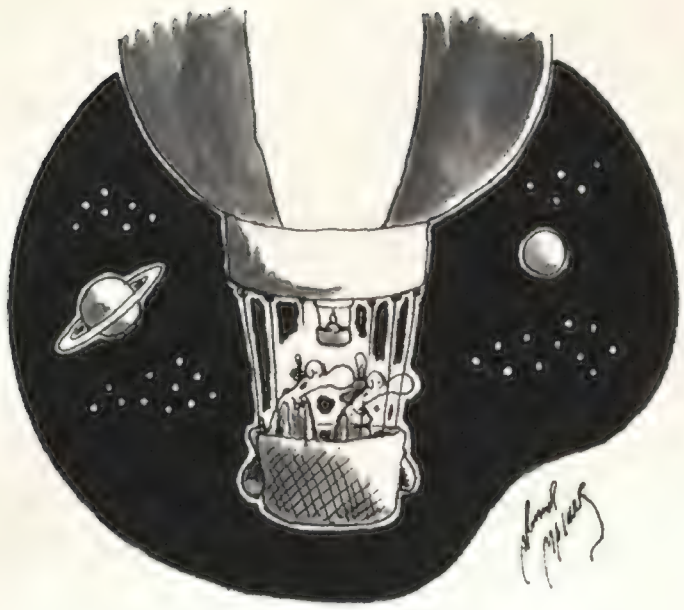
Mr. Cervoni's offer to sell the coordinates to the museum was turned down for a variety of reasons. First, a purchase such as this was beyond my authority. I did not seek higher authority because I did not consider an exchange for the information under the museum exchange program justifiable under the law and the Secretary of the Navy's instructions governing the program. Further, because the salvage, preservation, and restoration aspects of the project were unknown, the risks involved in the project and the potential costs to bring it to fruition argued against this approach. It was also not considered a viable option because Mr. Cervoni wished the transaction to take place within a certain time period, which would not have allowed sufficient time to acquire the approval of the Secretary of the Navy and the Navy Contracting Authority. I did not seek funding for this project from the museum's foundation because I did not consider it justified in view of the risks and unknowns. Further, requesting the foundation to divert funds from its primary purpose—expansion development of the museum—for such a venture was not appropriate. Contrary to Mr. Stafford's assertion, this was never considered a viable alternative.

I have no knowledge of the "Navy Saturation Dive Team" Mr. Stafford refers to. I did discuss a possible salvage of the TBD with a Navy Superintendent of Salvage representative (Mr. Stafford had no part in this communication). The conclusion was that determination of the feasibility of such a salvage depended on an on-site inspection. Such an inspection by the Superintendent of Salvage was not a viable option.

I presume that Mr. Stafford's implication is that the museum improperly disclosed privileged information to A & T Recovery Inc., to the detriment of Mr. Champlin. The museum neither requested nor received information on the TBD's location from the U.S. District Court, Southern District of Florida, where Mr. Champlin filed his claim. Information on the claim (which establishes the location of the aircraft as somewhere within a 19.275-square-mile area) was provided to the museum on January 27, 1995, by the Office of the Judge Advocate General (Admiralty Division) and again on February 22, 1995, by the Department of Justice. The two agencies provided the information as a matter of course, probably because the museum, being the Navy's assigned custodian of the aircraft, had a direct interest in the claim. In any case, the museum has not transmitted the information in the above documents in any form to any individual, agency, or organization (including A & T Recovery) outside the U.S. government. However, the information is available as a matter of public record, so there is no legal or ethical prohibition to such communication.

It should be pointed out that while A & T and others have made it known that they are interested in bidding on the salvage of the TBD, the Navy has made no commitments, arrangements, agreements, or overtures (other than the original discussions with Mr. Champlin) with anyone regarding this recovery.

The C-130 trade to which Mr. Stafford refers was an exchange approved by the Secretary of the Navy specifically for the purpose of funding preservation of the TBD, once it had been salvaged. An exchange for *salvage* has not been pursued since that time because the Navy is rewriting exchange policy, the completion of which is required in order to initiate any exchange. Mr. Stafford's suggestions that the C-130 exchange was improper is a reiteration of allegations made against the museum shortly after the exchange was approved. An independent Navy investigative body conducted an exhaustive and lengthy examination of these



"&@#% El Niño!"*

allegations, including an in-depth look at the value of the government equipment in the exchange. The resulting report unequivocally confirmed that neither the museum nor its foundation engaged in any illegality, impropriety, unethical conduct, or questionable or poor business practice. And it confirmed that the museum took prudent steps, well beyond those required by the Navy instructions, to establish the value of the equipment. If the equipment were in fact worth "millions," as Mr. Stafford asserts, this was certainly not recognized by the several contractors (civilians interested in C-130s) invited to bid on the equipment. Nor was it recognized by the Department of Defense agency that assessed the equipment (as scrap at $5,500 per aircraft hulk), or by the investigative report.

Space, Lies, and Videotape

Ever since I saw the late moonwalker Jim Irwin get heckled at a high school appearance, I've accepted the existence of Apollo skeptics as a sad reality ("Moonstruck," Flights & Fancy, Oct./Nov. 1998). I find it tragic that an estimated six percent of the public doubt the achievement of project Apollo. And yet there is a comic aspect to this. In a world where the president of the most powerful nation on earth can't keep his sex life secret, I have to chuckle at the suggestion that anyone who faked a lunar landing could succeed in covering it up.

—John Starr
Glendale, California

Engagement Etiquette

In "The Ravens of Long Tieng" (Oct./Nov. 1998), Ralph Wetterhahn states that the air war in Laos had "few rules." In fact, the rules of engagement in Laos were among the U.S. Air Force's strictest. According to the Pentagon Papers and other sources, rules for engaging the enemy on the ground and in the air emerged out of a debate involving officials in Vientiane, Saigon, and Washington. Ambassador William H. Sullivan in Vientiane closely monitored the air war, and if he protested an Air Force violation, high officials would be sure to inform the pilots involved. Dropping a bomb on even a single house in a friendly village was likely to get the guilty party in trouble. The U.S. embassy investigated such cases and financially compensated families of civilians that had been victimized by bombing errors.

—Arthur J. Dommen
Bethesda, Maryland

The Curious Habits of the American Osprey

In the cutaway illustration of the V-22 Osprey (Special Graphic Supplement, Oct./Nov. 1998), the crew member seated in the right front seat is holding the throttle control lever in his right hand and the cyclic in his left. This is the mirror image of reality.

—Warren V. Wandel
Fort Worth, Texas

The questions about the V-22's ability to autorotate ("Extreme Machine," Oct./Nov. 1998) made me wonder if the name "Osprey" should be changed to "Let Us-Pray."

—Blan Shattuck
Potomac, Maryland

Back to the Rickenbacker Saga

Since the airplane carrying Eddie Rickenbacker had a jammed directional loop, incapable of moving more than a few degrees ("The Rescue of Eddie Rickenbacker," Aug./Sept. 1998), the pilot should have made a 360-degree circle, noting the heading as the null point was passed. By doing so, he would have transformed the entire plane into a fully functioning loop antenna.

—Deryck G. Nuckton
Monterey, California

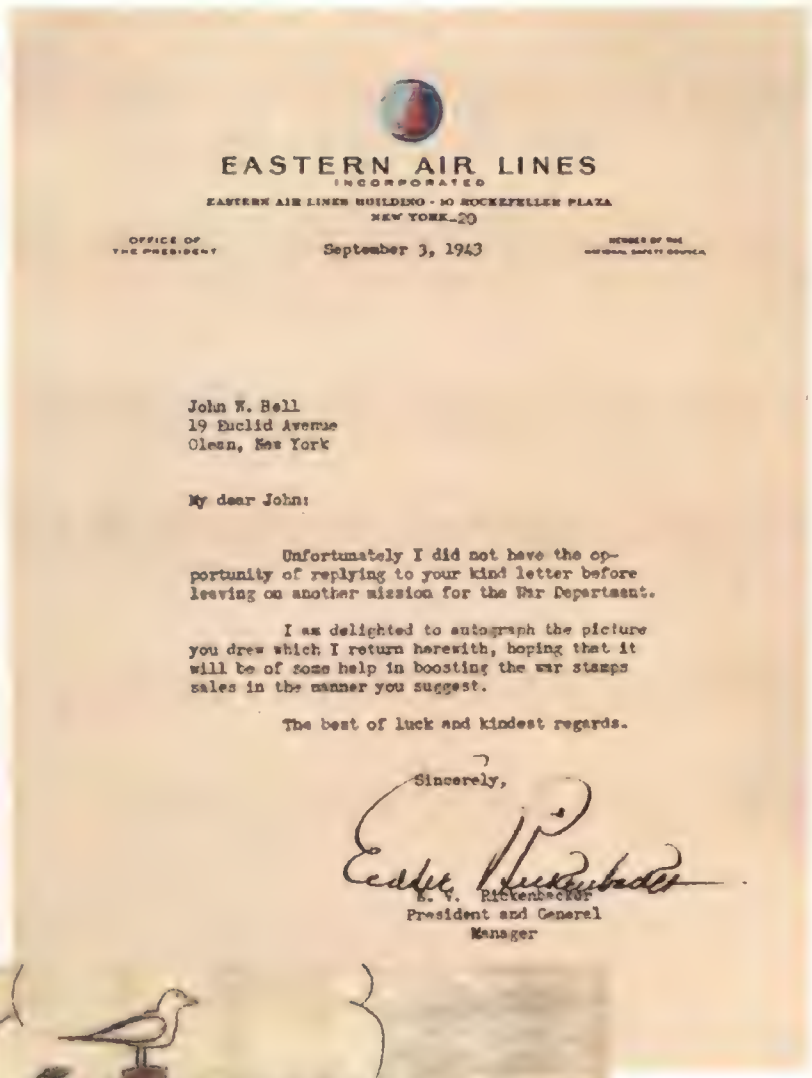
Though Eddie Rickenbacker complained that his crewmates were "second level," the person who was truly second level was Hap Arnold, who should have taken better care of Rickenbacker and hand-picked a crew for his mission.

—Matthew L. Shaffer
Castro Valley, California

The *Life* magazine account of the raft ordeal included an illustration of the seagull incident. I was 10 years old at the time, and I drew a copy of the illustration [*right*] and sent it to Captain Rickenbacker. You can imagine how thrilled I was that with all his responsibility to the war effort, he took the time to reply, and to autograph my drawing.

—John W. Bell
Largo, Florida

The author, W. David Lewis, replies: I remember seeing a copy of Rickenbacker's letter to John Bell when I was doing research at the Library of Congress. It is very characteristic of the diligence with which Rickenbacker responded to letters from children.



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John W. Bell
19 Euclid Avenue
Olean, New York

My dear John:

Unfortunately I did not have the opportunity of replying to your kind letter before leaving on another mission for the War Department.

I am delighted to autograph the picture you drew which I return herewith, hoping that it will be of some help in boosting the war stamps sales in the manner you suggest.

The best of luck and kindest regards.

Sincerely,

Eddie Rickenbacker

E. V. Rickenbacker
President and General Manager

Don't Underestimate the Russians

I was disappointed by the condescending tone of "Aiming for Arkalyk" (Aug./Sept. 1998). It wasn't just phrases like "pasty officials" and "the picture of ex-Soviet sleaze." The article focused on past mishaps and current problems. A Russian reporter could easily do the same to our space program by emphasizing Apollo 1 and *Challenger*, along with today's shuttle snafus.

A sense of superiority pervades the U.S. aerospace and high-tech industries. As a software engineer, I can assure you that the U.S. does not have a monopoly on brainpower. And access to information and technology has never been easier. Others can and will catch up.

—Jay Bolgatz
Litchfield, New Hampshire

Brotherhood of the Thor

I am writing a history of the Douglas Thor Intermediate-Range Ballistic Missile, which was in service with the Royal Air Force in the United Kingdom from 1958 to 1963. As most of the RAF Thor personnel were trained in the United States, and each RAF launch crew had a USAF Authentication Officer attached under the "dual key" system, I hope that some of your readers might have recollections of this underdocumented part of Anglo-American history.

—Frank Crosby
37 The America
Sutton, Ely
Cambridgeshire, England CB6 2NY

Rocket World

"Rocket Country" (Collections, Aug./Sept. 1998) states that the V-2 at the White Sands Missile Range in New Mexico is one of only five left in the world. There are actually far more, though many are simply shells. Together with a colleague, Sheila Fairbrass, I am working on the conservation of a fine, fully equipped V-2 at the Aerospace Museum at Cosford, near Wolverhampton in England. In the course of my research, I have tracked down 17 surviving V-2s: five in England, two in Germany, one in the Netherlands, two in Australia, and seven in the United States.

—John Becklake
Guildford, England

Mixed Reviews

I have a friend who takes pride in reading only non-fiction, no novels or stories. Another friend couldn't enjoy Alistair MacLean's novel *Athabasca* because it contained an error concerning the distance between valves along the Alaska pipeline. Pete Goldie, whose letter in the last issue protested *Air & Space*'s coverage of movies like *Armageddon*, reminds me of these people. Those who lack the imagination to enjoy these kinds of adventure books and movies must find life boring.

—Luther E. Franklin
Issaquah, Washington

Maybe *Armaggedon* deserves high marks for the accuracy of its depictions of space

technology and astrophysics ("The Wizards of What If," June/July 1998), but as far as geology and drilling go, I can tell you as a professional in the field that the movie is totally off the mark. For instance: In the low gravity you'd expect on an asteroid this size, how would you produce torque and downward pressure to operate the drilling bit? On Earth, the mass of the rig enables you to do that. But on a low-gravity body there'd be little weight and thus little penetration. (And for such a huge bit, that aluminum drill pipe seemed really wimpy.)

Why is it that even though they started drilling in hard ferrite, they ended up in mashed potatoes (material they could drill at a rate of two feet a second)?

What did the crew use to remove the rock cuttings? With a huge roller cone bit made for rotary drilling, you need pressurized liquid or gas to lift the rock chips out of the hole as the drill bit penetrates.

I guess I am just a bit picky because in the movies, most geologists and drillers are portrayed as bad guys.

—Thomas A. Herbert
Tallahassee, Florida

Corrections

Oct./Nov. 1998 "What I Learned at Kitplane Camp": We regret giving an incorrect area code with the phone number for information on the EAA Adult Air Academy. The correct number is (888) EAA-EAA9.

"The Broad Side of a Barnes Door" (Above & Beyond): Though the made-for-TV movie *Pancho Barnes* stated otherwise, the aviator made her first flight in a Travel Air 2000 in 1928.

"27,000 Seconds in Hell" ("Start Me Up" sidebar): When it fills the engine chambers, the liquid hydrogen is –420°, not –475°.

"Whose Planes Are They, Anyway?": The USS *Texas* (renamed the *San Marcos* in 1911) was a battleship, not a carrier.

"The Ravens of Long Tieng": We regret misspelling Dave Ankerberg's name.

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CONTEST

UNIDENTIFIED FLYING OBJECT:

Can you identify this airplane?

The airplane pictured above is a:

- Bell X-1D
- Leduc 022
- Dassault F-11
- MiG-18

In the past, so many readers have responded to our series of photographs of unknown aircraft that we decided to design a contest around photographs of rare and unusual aircraft (except that this time around, we know what they are). Now you can qualify for prizes, one of which will be awarded after each photograph is published, and one grand prize at the conclusion of the contest:

- awarded following each edition—
  a Garmin GPS III satellite navigator

- GRAND PRIZE—flight training worth
  $2,000 from the Be-A-Pilot™ program.

All you have to do is select an answer from the choices listed above, then mail a postcard with your name, address, and your answer to: AIR & SPACE, UFO Contest, 901 D Street SW, 10th Floor, Washington, DC 20024. Identify the airplane correctly and you'll qualify for the drawing to award the prize.

Before entering, please read the detailed rules, which are posted on page 96.

CONTEST

Takes a Licking, Keeps on Ticking

Ka-*thunk*! Two Zagi-LEs have just collided in mid-air. One hurtles to the ground, forcing its flier down the hill in pursuit, while the other one soars on victoriously. "Kill! Kill! Eeooww! I stuffed him," shouts 15-year-old Sam Siegel.

The wafting breezes and a bright blue sky laced with cumulus clouds make it another perfect day for flying on Snake Hill in Malibu, California. More than a dozen Zagi owners have gathered for a Fur Ball, a free-for-all combat meet. Designed and manufactured by Jerry Teisan, the Zagi-LE is the model flying wing that has become the standard in slope combat—extreme competitions between radio-controlled models. You can build one in the morning, fly it in the afternoon, and attack and crash as often as you like—they're virtually indestructible. "At one combat contest I had 50 mid-air kills and 25 crashes to the ground—tons of abuse," says Teisan. "I've had a truck run over one and a dog intercept another, thinking it was a weird kind of Frisbee, and they flew just fine with tread marks and fang dents."

Teisan's Trick Radio Control company offers three models, ranging from $45 to $100 (see www.zagi.com). They're not just for kids, klutzes, and crazies, says Teisan, who's known in model airplane circles as the Flying Wing Guy. "Experienced fliers will get really good, because they'll be able to do what they never could do with a high-performance fiberglass or carbon fiber airplane."

Teisan has seen his competition come and much of it go. "Everybody sort of scoffed at the whole flying wing thing and for two years the other major model plane manufacturers left me completely alone," he says. During that time, Zagis garnered a sky-high reputation. Nobody's scoffing now. Zagi flier Jim Thorne put it this way:

There once was a sloper quite shaggy,
Who was trying to knock down a Zagi.
He flew without fear
and thought he was clear,
But took home his plane in a Baggie.

Although Teisan launched his company just four years ago, he's been building model airplanes since childhood. Throughout three careers—as an industrial and fashion photographer, a building trades consultant, and a fisherman, Teisan flew his model airplanes whenever he could. By 1990 he was spending his spare time making custom composite racing aircraft and selling them on a one-by-one basis. But when he saw a foam airplane at one of the local flying fields, it got him thinking. "The worst thing about learning to fly model planes is you spend 20 to 30 hours building this fragile thing out of sticks and balsa wood, and then you finally get it up in the air and—*boom!*—within three minutes of stick time it crashes and breaks," he says. "Then, even if you get it back together, it never flies as good. But the new foams coming out returned to shape after impact."

Teisan combined his passion for flying wings with the latest in foam technology. He perused old German airfoil books, settling on a wing design attributed to "Zagi." He cut wings from expanded polystyrene or styrofoam and attached leading edges of soft expanded polypropylene. "Then I invited a bunch of friends over, and we installed their radio gear and went out to test fly them," he says. "The one I called the Zagi-LE worked the best."

The Zagi-LE was such a hit everybody at the hill that day wanted one. Within months, Teisan was in business producing Zagis from his home in Venice, California. Today he is shipping about 500 every month around the world. "These days, kids who have grown up with the computer know a joystick and gimbal

JERRY TEISAN

COMPOSITE BY DOUG REEL

from the time they crawl, and their eye-hand coordination is just incredible," says Teisan. "They're learning to fly in a day, but the airplanes have to be indestructible for that learning process."

Sure enough, two boys in today's Fur Ball competition took top honors—Sebastian Mark, 9, walked away with the trophy, with Sam Siegel coming in second. Despite more than 100 kills and half again as many crashes, everybody at Snake Hill went home with their Zagis intact and only their egos bruised.

Now that his Zagis have taken off, Jerry Teisan has accomplished all his childhood dreams—except one. "I always wanted to be a pilot," he says, "of full-scale airplanes."

—A.J.S. Rayl

UPDATE

Revisiting Mach 2

Last September two veteran NASA pilots became the first Americans to fly the Russian Tu-144 supersonic transport ("Encore for an SST," Oct./Nov. 1995). Robert Rivers from the Langley Research Center in Virginia and former astronaut Gordon Fullerton from the Dryden Flight Research Center in California made three evaluation flights, including two to Mach 2, as part of the NASA/Boeing High Speed Research program, which is geared toward designing an efficient second-generation U.S. SST. Another five flights will complete a program that will ultimately total 27 flights.

ERIKO SUGITA/REUTERS/CORBIS-BETTMANN

Richard Branson (top) and balloon co-pilot Per Linstrand: Will Branson's attempt to start a foreign-owned U.S. airline fly?

Virgin Territory

Richard Branson has crossed both the Atlantic and Pacific oceans by balloon and the Atlantic by boat, breaking records but at times barely escaping with his life. After repeated failed attempts to circle the globe by balloon, he explained his dedication: "I knew that I would attempt another balloon flight because it's one of the few great challenges left."

Branson has found another challenge to go along with ballooning. The British subject is trying to overturn a long-established U.S. aviation law that prevents foreign-owned airlines from operating within the United States. Such carriers can provide service from the United States to other countries, but to fly between U.S. cities, an airline must have at least 75 percent U.S. shareholders.

Branson presides over a huge and remarkably diverse business conglomerate, all parlayed from his early success with a magazine and a record store. Now, from Virgin Cola to Virgin Vodka, from Virgin Radio to Virgin Megastores and much more, a consumer can live a life, as one observer put it, "of perpetual Virginity." In 1984 Branson founded Virgin Atlantic Airways, a long-haul carrier based in London. Later came Virgin Express, based in Brussels, with intra-European service. To those he'd like to add Virgin America, but U.S. law stands in his way.

To launch his campaign for access to the domestic U.S. market, last September Branson hosted a luncheon in Washington and then made the rounds on Capitol Hill. Virgin's arrival would be good news for the flying public, he pledged: "We all know that consumers today in many U.S. markets face a dwindling number of choices of which airline to travel; they are unhappy at the deteriorating level of service...and they resent the steadily increasing prices.... Virgin America will give the big six some real competition, and I promise all of our unusual features—value for money, great service, and plenty of fun." On Virgin Atlantic "fun" has meant such amenities as in-flight massages, putting greens at departure lounges, and motorcycles or Land Rovers for business and first-class passengers to ride from Heathrow into central London.

At the luncheon, in a sea of conservative Washington power suits, Branson, known for his flamboyant, irreverent style, looked merely conventional in a casual tweed outfit, open collar, beard and flowing hair. A lawyer sniffed, "Maybe if this deal goes through he'll get enough cash to buy a tie."

For Branson, the Washington appearance was fairly tame. Branson's luncheon was held in the historic Decatur home, and this time he merely compared himself to the widow of Stephen Decatur, U.S. naval hero in the War of 1812. When Decatur died in 1820, not long after the house was completed, his wife could not assume ownership because the law then did not permit women to own property. "Like the widow of Stephen Decatur," Branson said, "I am hindered from trying my hand in this market by an outmoded law that no longer serves a useful purpose."

What are his chances of getting that law changed? At first glance, not so good, since U.S. airlines are not known to welcome new players, and they know how to make their views known in Congress. But industry analyst George Hamlin, senior vice president of Global Aviation Associates, suggests they may not resist too strenuously, at least in public, for fear of endorsing protectionism. Besides, Hamlin says, any law change would likely be reciprocal, and that could open up opportunities for U.S. airlines in foreign internal markets. But if Branson is allowed to establish Virgin America, Hamlin also predicts, "he would face massive competitive retaliation," or price wars to the rest of us.

Though Branson evoked the memory of Stephen and Susan Decatur, there was one aspect of their story on which he didn't dwell: Decatur was killed in a duel.

—Lester A. Reingold

Distinguished Visitors

Both men were born in 1923. Both were trained as navigators. Both failed to see action in World War II. Both saw plenty of it in Korea, where both flew harrowing night missions in Douglas B-26s.

NASM

As Hans Petermann and James Warren relived their youths in a hospitality room at Circus Circus in Las Vegas, oblivious to the beckoning lights of the nearby casino, they conversed about another point of intersection: Both had been awarded Distinguished Flying Crosses.

"Mention the Distinguished Flying Cross and most people don't know what the hell you're talking about," said Warren, a Tuskeegee Airman who won three DFCs. "That's why I came here—because your peers understand what you've been through."

Including Warren and Petermann, 143 DFC recipients gathered last September for a convention of the Distinguished Flying Cross Society. Although most of the growing organization's 1,400 active members are World War II Air Force veterans, others served in the Army, Navy, Marine Corps, and Coast Guard in Korea, Vietnam, and the Persian Gulf.

Authorized by an act of Congress in 1926, the DFC is usually awarded for "heroism and extraordinary achievement in flight," as the citation typically reads. Although Charles Lindbergh, Amelia Earhart, and Richard E. Byrd were among the first recipients, the award is now limited to military aviators, and it's most commonly earned in combat.

Bob Matus, 62, a soft-spoken navigator from Fort Worth, got his for guiding a Boeing KC-135 past Laotian surface-to-air missile sites to refuel a pair of stricken F-105s. White-haired Louisianan William Bryant was cited for landing his Grumman TBF Avenger on a flight deck after Japanese ground fire blew out his tires. The TBF flipped over on touchdown. "Fifty years later, my neck still bothers me," he says.

Oddly, nobody, not even the government, knows how many DFCs have been issued. This uncertainty rankled Al Ciurczak, who earned his medal as a gunner on a B-24 flying out of the Aleutians and the Mediterranean during World War II. When the Department of Defense couldn't help, he started searching for DFC recipients himself. "I wrote about 2,500 letters, and, not only that, I hand-wrote them," he recalls, and sent them to every name on a DOD list of personnel that had an Air Force connection. "Then I went through *Who's Who* and wrote 1,500 more."

Ciurczak never came up with a definitive count of the total number of DFC awards ever given (he guesses 75,000 to 80,000). In 1994, though, working out of his home in Capistrano Beach, California, he founded the Distinguished Flying Cross Society. The organization held its first convention in 1996.

Though this year's second convention featured the standard business meeting and banquet, it was mostly a forum for swapping war stories—some humorous, many tragic, all compelling.

Wearing a flightsuit festooned with organizational patches, Dave Steiner of Lafayette, Colorado, remembered "flying unarmed, alone and afraid in a 30-year-old airplane, into combat at 10,000 feet." John Wood, a retired math professor with a New York accent and attitude, pulled out a dog-eared record of the missions he flew over Europe as a B-17 ball-turret gunner. "Of the eight planes I was on, six were later shot down," he said.

"That's the thing about the Distinguished Flying Cross," Warren said. "You can't buy them down at the corner drugstore. To earn one of these damn things, you have to bet your ass."

—*Preston Lerner*

Tuning In

If you want to listen for extraterrestrials, it helps to have good hearing. That's why researchers from the California-based SETI Institute set up a monitoring station at the Arecibo Observatory in Puerto Rico. Nestled in the jungle-covered hills of the island's northern coast is a 1,000-foot-diameter aluminum dish—the planet's most sensitive hearing aid for celestial radio waves.

The Search for Extraterrestrial Intelligence team arrived last September for the first of six 20-day pilgrimages to Arecibo, which reopened to scientists this summer after a $27 million upgrade (see "Arecibo, Still Numero Uno," Soundings, Oct./Nov. 1997). SETI's good fortune—telescope time is in great demand and usually apportioned in one-week periods—stems from the institute's previous life as a NASA-sanctioned program. Congress dumped SETI in 1993, but it survives on the generosity of private donors.

It took more than a month to install the one-of-a-kind computers, signals processors, and communications relays that are the guts of Project Phoenix, the SETI Institute's targeted search of a thousand nearby sun-like stars. The stars emit energy over the entire electromagnetic spectrum, including radio frequencies. The SETI receivers sift through the incoming starlight in 20-megahertz bites, looking for a powerful emission that appears on just one frequency—a most unnatural phenomenon.

Although there are billions of radio frequencies to tune in to, SETI researchers are interested in two billion

PEYTON HOGE

The annual Staggerwing/Travel Air/Beech Model 18 convention in Tullahoma, Tennessee, last October marked the 25th anniversary of the Staggerwing Museum Foundation and the dedication of the new Twin Beech 18 facility, which houses three models of the 18. (Can a Beech Bonanza division be far behind?) Some 50 aircraft flew in for the bash, including 16 Staggerwings and 17 D-18s.

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frequencies between 1,000 and 3,000 megahertz, a range that encompasses the natural radio emission of hydrogen—the most prevalent element in the universe—and the hydroxyl radical, OH. The two elements combined make H_2O, a fitting cosmic metaphor (at least to Earthlings) in the search for intelligent life. The frequency range is also one of the quietest areas of the electromagnetic spectrum, which makes it ideal for transmitting radio signals over long distances.

But Arecibo's sensitive ear has a distinct drawback: The signals of intelligent life on Earth are all too apparent. The scientists spent their first few observing periods identifying frequencies that are so polluted by terrestrial interference they need to be masked to prevent the system from reacting as if it has found ETs. It's a painstaking, time-consuming procedure to point away from the star to see if the signal disappears, then re-target the star to reacquire the emission. The work is done in concert with a backup telescope at Jodrell Bank, England.

Jill Tarter, who helped shape actress Jodi Foster's role in the film *Contact,* leads the team. The work is tedious and frustrating, but there are rewards: Every morning, the only known ET signal that the SETI receivers can hear warbles a wake-up call from far beyond the orbit of Pluto. It is Pioneer 10, broadcasting on Milky Way radio with less energy than a night light. As long as the scientists can pick up Pioneer, they at least know their equipment can hear.

—Irene K. Brown

UPDATE

Raising Buffalo

It was thought that not a single Brewster Buffalo had survived World War II ("The Sorry Saga of the Brewster Buffalo," June/July 1996) until last summer, when U.S. salvager Gary Villiard fished out of an icy lake in Russia's Karelia a Finnish example in splendid condition, its tires still inflated and oil still in the lines. Villiard said he found the Buffalo by comparing Russian and Finnish pilot reports with the recollections of a soldier who'd seen it crash in 1942.

KEN MIERZEJEWSKI (2)

Time Capsule

Freedom 7 flew only once, for a mere 15 minutes on May 5, 1961, carrying Alan Shepard in a suborbital arc that reached 116 miles over Earth. Though confined to the planet's surface in the decades since, America's first manned spacecraft has hardly remained stationary. For two years it was part of the Smithsonian's traveling exhibition, helping to celebrate the institution's 150th anniversary across the country. Now it has taken up residence at Shepard's alma mater, the U.S. Naval Academy in Annapolis, Maryland.

On loan from the National Air and Space Museum, *Freedom 7* will spend at least five years in the academy's visitor center, which receives 1.5 million visitors annually. The bell-shaped capsule is displayed in a seemingly custom-designed rotunda, with the Chesapeake Bay just outside. Guests can peer through the hatch and see that Shepard didn't so much board the capsule as wear it. He later recounted that once in place, he could move his eyeballs and not much more. On the day of the launch, he found a notice on the instrument panel: "No Handball Playing In Here."

Freedom 7 is the centerpiece of an exhibit on "Grads in Space." The Naval Academy is happy to point out that so far it has contributed 50 members to the astronaut corps, more than any other educational institution.

Astronauts past and present gathered for the capsule's installation ceremony last September. Current astronaut Wendy Lawrence, veteran of three shuttle flights, was asked to compare her experience with Shepard's. "My last flight was the 91st of the shuttle," she said. "How do you compare that to the first of a kind? We've simply followed in the footsteps of Rear Admiral Shepard's flight."

Astronauts who were Naval Academy graduates have been contributing artifacts to the visitor center, and keynote speaker James Lovell of Gemini and Apollo fame presented two during the ceremony. One was a U.S. Navy flag, which orbited Earth with him on board Gemini 7. The other, he said, was never in space. It was a history term paper he wrote as a midshipman at the academy. While most of his classmates tackled various aspects of military history, the young Lovell, long a rocketry enthusiast, predicted in 1952: "The big day for rockets is still coming. The day when science will have advanced to the stage when flight into space is a reality and not a dream."

The tributes to Naval tradition and achievement in the space program were not lost on the midshipmen in the audience. As they were leaving, one of the students commented earnestly to two others, "That was an amazing evening. Do you realize how lucky we are?"

—Lester and Susan Reingold

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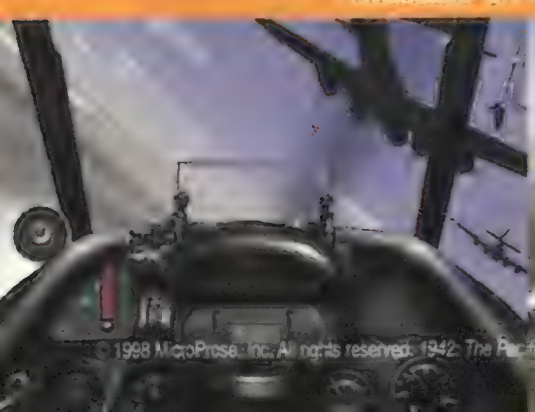

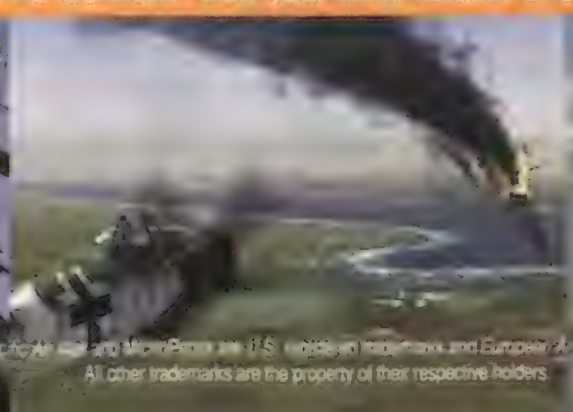

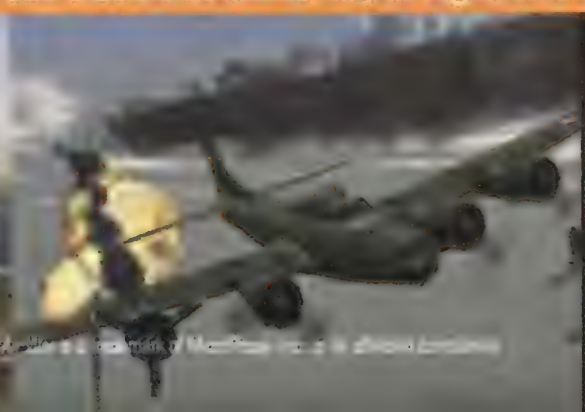

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The Space Capsule's New Clothes

After traveling to the moon and back, the Apollo 11 command module, *Columbia*, is now on permanent display at the National Air and Space Museum. And despite enduring the harsh conditions of space, *Columbia* is surprisingly, well, vulnerable. Prominently positioned in the center of the glass-roofed Milestones of Flight gallery, the command module, which returned astronauts Buzz Aldrin, Neil Armstrong, and Michael Collins to Earth on July 24, 1969, is prey to solar radiation, moisture, dust and dirt, and the probing hands of millions of visitors.

Until last summer, the only thing standing between *Columbia* and harm's way was a rather flimsy one-eighth-inch layer of acrylic. It had cracked in numerous places, and the bottom portion was clouded by deposits that had slowly leaked from what remains of the heat shield (after *Columbia* parachuted into the Pacific, the honeycombed heat shield absorbed saltwater, and preservationists were unable to remove all of it because doing so would have altered the capsule's as-returned-from-space condition). Further marring the clarity of the acrylic covering were the actions of visitors, who "like to touch the spacecraft. It means something to them," says Amanda Young, who oversees the preservation of *Columbia*. "Visitors press on the heat shield cover—a lot." But each press created a bellows effect that sucked in dirt, dust, and even insects from the heavily trafficked gallery.

In August, *Columbia* received a much-improved covering fabricated and installed by Greg Cottrell, who owns a Maryland-based company that makes acrylic globes and aircraft canopies. The new acrylic covering is twice as thick—and far less flexible—than the old one. And to counteract any remaining bellows effect, Dave Heck, chief of the Museum's audio-visual department, devised a method to keep dust out. He installed a length of plastic tubing that runs from an air compressor in the Museum's basement into the capsule's covering. "We're bleeding maybe three or four cubic feet a minute of this dry clean air into the enclosure," says Heck. "The idea is to cause a positive airflow out of the enclosure to keep the dust out. If we're lucky, we wouldn't have to go back in there and ever clean it."

But if they do, the staff will have an easier time of it, thanks to the cleverly designed and easily removed covering. No part of the self-supporting acrylic case comes in contact with *Columbia*'s delicate surface; a minimum half-inch separation is maintained between the two. It took Cottrell six weeks to make the 13 panels that form the covering—which involved heating six- by 10-foot sheets of acrylic and cutting them to fit a wooden mold. Cottrell and three assistants then spent three weeks assembling the panels using more than 400 stainless steel screws. Cottrell, who remembers the Apollo program with reverence, says: "I'm determined when I get a job like that, I'm going to do it the best it can be done. It's an honor."

—Diane Tedeschi

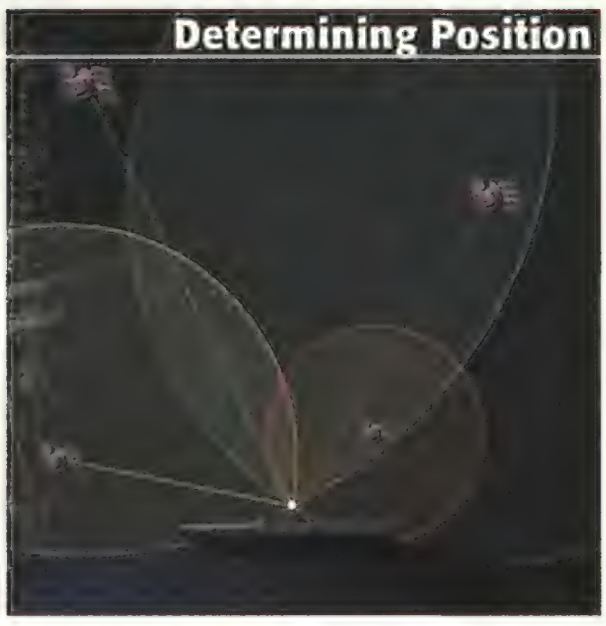
ERIC LONG

It's About Time

The cesium atom is our friend. It just so happens, because of the arrangement of its little orbiting electrons, that when an atom of this 55th element of the periodic table is heated just a tad by microwaves, it radiates energy at 9,192,631,770 Hertz or cycles per second. (Fun fact: In 1967 the 13th General Assembly on Weights and Measures decided to use this transition frequency of cesium as the basis for defining the unit of time known as the second. A second became the length of time it takes light emitted by an irradiated cesium atom to cycle 9 billion-plus times.)

If you think of each one of those cycles as a single unit of time, you get an idea of the accuracy with which time can be measured by a cesium atomic clock. The most accurate of these clocks have an

CAROLYN RUSSO



NASM

A position fix once took a sextant and some math—now all you need is a handheld GPS receiver (top). The receivers track a network of satellites to pinpoint location.

error of only one second every 1,400,000 years. That's why, if you drop by the National Air and Space Museum, you'll know what time it is, as the telephone voice says, "exactly." A tiny computer connected to an antenna on the Museum's roof receives data from the cesium atomic clocks that are carried aboard the satellites of the Global Positioning System, which, in conjunction with microprocessors in receivers on the ground, can pinpoint positions anywhere on Earth.

The GPS receiver is part of a new exhibit, "GPS: A New Constellation," which opened in the Museum on October 17 in conjunction with a new planetarium show explaining the techniques of celestial navigation. The time display emphasizes a basic principle of the system: The key is accurate timing (see "You Are Here," June/July 1992).

"Commercial applications began with timing," says Andy Johnston, a geographer in the Museum's Center for Earth and Planetary Studies who contributed to the script for the exhibit. Johnston and his colleagues at the Museum have used GPS, however, the way most people are using it: to find out where they are.

"We have an extensive archive of Landsat imagery of Washington, D.C.," Johnston offers as an example. "With GPS receivers, we can locate ourselves within the satellite imagery" to get a better understanding of what the satellite pictures show from 440 miles away. The Landsat images show a general picture of urban sprawl and its impact on surface water and forest cover. "Geo-referencing," the term for what Johnston does when he pinpoints locations within the images, identifies the neighborhoods and even the streets within the neighborhoods that are affected.

Among the artifacts in the exhibit is the receiver Johnston used in a recent project to map lava flows from a volcano in southern Peru. This receiver, contributed by Trimble Navigation Limited, the primary underwriter of the exhibit and planetarium show, is one of several such units on display, including those used when the Global Positioning System was primarily military technology. (The satellites are funded, launched, and operated by the U.S. Air Force.)

Among the several brands of GPS receivers available, some provide a more accurate position than others, but all work on the same principle. The receiver determines position by measuring the amount of time it takes for a radio signal to reach it from each of four of the 26 satellites now in orbit.

Since radio waves travel at the speed of light (186,000 miles per second), if the receiver knows the precise time the signal left the satellite, it can divide the signal's travel time by the speed of light to determine its distance from the satellite.

Suspended above the GPS is a one-quarter-scale model of a Navstar GPS satellite. Curator Paul Ceruzzi has been unable so far to obtain a test model of the satellite, but he wanted the exhibit to have some representation of the part of the system that's in orbit. "It's easy to forget when you're holding a receiver [that gives you your latitude and longitude] that you're also using a transmitter way out in space," he says. "The satellites are the heart of the system."

You might say they're what make the whole thing tick.

—Linda Shiner

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.

December 5 National Air and Space Society Lecture. "Apollo 8 + 30 Years," an evening with Frank Borman. Borman, whose career includes stints as a fighter pilot, test pilot, Gemini and Apollo astronaut, and president of Eastern Airlines, will talk about his trip around the moon on Apollo 8. Langley Theater, 8 p.m. To purchase tickets ($10 for members, $15 for non-members), call (202) 357-3762.

National Air and Space Society

As a Founder Member you can help support the most significant effort in the National Air and Space Museum's history: the new Dulles Center, to be built at Washington Dulles International Airport. For information, call (202) 357-3762, or write to: The National Air and Space Society, NASM, Room 3608, MRC-310, Smithsonian Institution, Washington, DC 20560; e-mail: nass@sivm.si.edu

Curator's Choice

Once a week a Museum curator will give a 15-minute talk about an artifact. Dec. 2, Vanguard satellite launch vehicle; Dec. 9, LINK pilot trainer; Dec. 16, Hubble Space Telescope structural dynamic test vehicle. Meet at the Gold Seal in the Milestones of Flight gallery at noon.

FOR THE CAR

It's a bird and *a plane, and if you live in Virginia, it can be on your license plate. As part of an effort to raise funds for construction of the National Air and Space Museum's Dulles Center at Washington Dulles International Airport, the Museum is selling license plates featuring a Lockheed SR-71 Blackbird reconnaissance aircraft. The 700,000-square-foot building will provide a much-needed home for some 300 air- and spacecraft, including the space shuttle* Enterprise, *a Boeing B-17 Flying Fortress, an F-4 Phantom, the B-29* Enola Gay, *and, of course, an SR-71. The Blackbird plate is $25; personalized plates are $35 and can include up to six characters. To order, call (202) 357-3762 or visit the Dulles Center Web page on the NASM Web site at www.nasm.edu (click on the Dulles Center icon).*

Squeeze Play

JOHN KACHIK (2)

Ziggy was a little guy. He stood about four feet tall—and that was while wearing shoes with thick soles.

When he applied for a job at Douglas Aircraft back in 1949, a plant manager took one look at him and knew he would be worth his weight in gold. Airplanes have all sorts of nooks and crannies where a diminutive guy like Ziggy would be of immense value.

During his stint at Douglas, Ziggy's talent was put to good use by nearly everybody. He was threaded between impossibly tight steel hydraulic tubing in AD-1 Skyraider dive bombers to gain access to some remote area for a repair that would otherwise entail partial disassembly of the airplane. The workers would lift him up so he could poke his head into the general area, then guide him like a piece of cooked linguine to the desired position, despite his occasional mild protests.

Ziggy was lowered into fuel tanks, sometimes head first. He bucked rivets in unimaginably tight spaces. He could even get his hands into filler necks of hydraulic reservoirs. Sometimes he would get an arm, hand, or ankle jammed between parts of the airplane. When that happened, Ziggy knew how to completely relax, which was important. If he tensed up, he'd never get out. Usually this resulted in his being able to extricate himself, with no help from others. But on occasion, we had to spray oxygen leak-check fluid on his arms or legs to make them slippery enough for us to pull him from between a couple of sections of tubing that had snapped over his knee or elbow like a bear trap.

One day, a cable tension check and possible re-setting was deemed necessary in the aft end of an AD-1. To gain access to the area, the right dive brake would have to be opened. A mechanic would have to hydraulically actuate the dive brakes to a partially open position. These large surfaces (one on each side of the aft fuselage and another on the bottom) could be extended in flight at about a 45-degree angle to keep the airspeed within limits during a near-vertical dive. On the ground, however, if one actuated the dive brakes carelessly, the bottom one would strike the ground and be grievously crushed, and the action would lift the airplane's tail up off the ground (which would alert everyone to the stupid thing you had just done).

But by using the emergency hydraulic pump prudently, the dive brakes could be nursed partially open. Then one could shove the lower brake up by hand as well as push the port side brake closed and thus, by displacing the hydro fluid, fully extend the starboard one. This allowed access to a little round hatch that led to the aft fuselage.

Enter Ziggy, carrying a tensiometer and flashlight. Mechanics lifted him up, he poked his head inside, and then he squirmed through the opening.

It was very dark inside the AD-1's aft fuselage. There were no ports or windows—just specks of light from lots of little drain holes drilled through the lower fuselage. When Ziggy's flashlight was off, the tiny points of light from all the holes looked like stars in the night sky. But the "sky" was below, not above. It was enough to give him vertigo.

While he was setting and testing cable tension in the aft fuselage, someone had the need to spread the wings of this folding-wing aircraft. The guy climbed up to the cockpit from the left side, which is standard operating procedure for entry. From his new vantage point, he could readily see that the left dive brake was closed, as well as the bottom one. He could not, however, see the open right dive brake. Before actuating the emergency hydraulic pump, the mechanic checked the position of the various hydraulic controls and noted that the dive

brake control was in the "extend" position. Not wishing to bash up the lower dive brake and lift the tail off the ground, he slapped the control to "closed" and actuated the hydraulic pump. Before the wings even began to spread, the right dive brake slowly closed, covering the little round hatch in the side of the fuselage and trapping Ziggy in the aft end of the airplane.

Other airplanes were engaged in engine run-ups, so no one would hear Ziggy shout. There was no danger of him suffocating, however. It was just that he would be lonely back there, and his flashlight batteries would not hold out forever. Then he would have only that inverted planetarium show to amuse him until someone noticed he was missing, or the engines were shut down and his muffled shouts might be heard.

Looking at his watch, he noted that it was break time. Everyone would be across the flightline alongside the hangars, having a smoke or coffee. Ziggy, conserving his flashlight batteries, sat in the blackness, studying the stars. Later, checking his watch again, he determined that break time had been over for 10 minutes (and even Douglas mechanics should be back on the job by that time).

He began to worry. He recalled hearing the hydraulic noise of the wings being spread (as well as that of the dive brakes closing). It suddenly dawned on him that they usually spread the wings before an engine run. If they started the Wright R-3350 engine, the fumes might asphyxiate him.

Then he got a humdinger of an idea, a way to signal those outside that he was inside. He reached up, groped around, and found one of the rudder actuation cables. Because of the large rudder mass, he had a difficult time moving the hard-to-grasp small-diameter rudder cable, but finally he managed a languid fore-and-aft motion, which, he knew, would result in the rudder swinging slowly back and forth.

The mechanic who had spread the wings (and who had inadvertently closed the dive brakes) noticed the movement as he ambled toward the airplane, returning from his extended break. He saw no one near the rudder or up in the cockpit. Baffled, he walked clear around the back of the airplane, still not seeing a soul.

Who's in the cockpit? he wondered. *Whoever it is must be under the instrument panel.* He climbed up on the wing and peered under the instrument panel. He gasped as he watched the rudder pedals eerily move to and fro, full left rudder, then full right. He looked aft toward the rudder, which was moving in synch with the pedals. Yet there was no one back there either. He knew the AD-1 had no autopilot. The rudder pedals were not hydraulically or otherwise assisted. It was strictly cables from pedal to rudder.

He hurried to the next airplane on the flightline and, shouting above the din of a nearby running engine, told the two mechanics what he had seen. He pointed to the rudder, which was still swaying rhythmically. Then he got the mechanics to come up on the wing and look into the cockpit. Stunned, they saw the rudder pedals moving by some mysterious force.

One of the mechanics was quite religious. He thought the episode only slightly less miraculous than a vision of the Virgin Mary appearing on a rusty hilltop water tank. He swung his head back and forth, between the oscillating pedals to his left and the swaying rudder to his right. The other mechanic had to snap him out of it, for he was fearful the agog one would do something irrational, like tear into the hangar and call the *Los Angeles Times*.

Two more mechanics, unaware of the apparent miracle, walked up. "Where's Ziggy?" they shouted to the guys on the wing. "We need him to find a magnet some goon dropped into the hell hole."

"Ziggy? He was adjusting rudder cable tension on 519," the miracle observer replied.

"Wait a minute," the guy who had closed the dive brakes shouted, "this is 519! Poor Ziggy! He's trapped back there in the ass end trying to signal us with the rudder!"

They got the dive brake opened and Ziggy came out, mole-like but unperturbed. He got a hurried and insincere apology, then was spirited off to a different airplane, where he was stuffed head first into the tiny area where the dummy had dropped the magnet.

—O.H. Billmann

The Count's Flying Houseboat

NASM

Poised on Northern Italy's Lake Maggiore in 1921 for its maiden flight, the Caproni Ca 60 Transaero looked like a houseboat with wings. Lots of wings—nine of them, 98-foot spans in three triplane tiers. There was no tail assembly; the three sets of wings were placed on the houseboat at bow, stern, and midships. And the fuselage really was a 75-foot-long, slab-sided houseboat, with seats for 100. Eight 400-horsepower Liberty engines were installed to power this forest of struts and wires skyward, then across the Atlantic to New York.

Transatlantic passenger service by air was a compelling dream in the early 1920s. The hulking Transaero would have been dismissed as just another harebrained design had it not been the inspiration of Count Gianni Caproni. A native of Alpine Italy, Caproni had earned a civil engineering degree in Munich, studied electrical engineering in Belgium, then devoted himself to aeronautics in France. His first design, the Ca 1 monoplane, flew in 1910. The Caproni company soon became one of Italy's leading aviation manufacturers.

The count next produced an 80-horsepower three-seat monoplane, which in 1912 set the Italian speed record, around 90 mph. The speedster flew in the Italian military until 1912, when France and England temporarily grounded monoplanes after a series of crashes raised questions about the structural integrity of the design. Caproni shifted to biplane and triplane designs, which led to World War I bombers like the three-engine Ca 32 and Ca 47.

The lumbering Capronis were second in size only to Igor Sikorsky's monster Russian bombers. In contrast to the relatively few Sikorskys produced, Caproni bombers rolled off British, French, and U.S. assembly lines by the hundreds. At war's end, it was inevitable that the apostle of big airplanes would apply his design genius to transatlantic passenger craft. The Ca 60's design evolved from his triplane bombers: If one set of triple wings could loft a seven-ton bomber, then three sets should do the job for the 20-plus tons of houseboat.

Though ungainly, the Ca 60 was impressive. Some 170 struts supported its wings. The dozen multi-pane and elegantly draped windows were to afford passengers panoramic views of the waves. Stability on the water was provided by two large pontoons. Vertical control in the air was to be provided by elevators mounted on the central set of wings. Though the craft had only one pilot, its engines were manned by a crew of engineers who communicated through a nautical telegraph system.

In early March 1921 the Transaero was ready for its first flight. Engines roaring, it began its takeoff run along the calm surface of 40-mile-long Lake Maggiore.

At this point, accounts differ. Some sources state that on March 2, the Transaero lifted majestically from the water and flew for more than a mile before gliding back to the surface, à la Howard Hughes in the sole flight of another ill-fated eight-engine monster seaplane 26 years later.

Others claim that the Ca 60's first—and only—flight was made on March 4. All agree that this flight was the final one. But there's disagreement on the details. Some say the Transaero made such a bad landing that major reconstruction would have been required. According to this account, the seaplane was dismantled and the project abandoned.

Others maintain that at an altitude of 60 feet, ballast shifted, the center tier of wings collapsed, and the grand design plowed into the lake. Caproni, these accounts claim, intended to rebuild the machine, using the salvaged portion. But shortly thereafter, it burned in a fire of unknown origin.

Though the debacle doomed Caproni's hopes of earning fame for transatlantic passenger service, it did not end his company's role as a producer of civil and military aircraft. In the 1930s, Caproni craft held three piston engine world altitude records; the last, 56,046 feet, set in 1938 in a Ca 161, still stands. And in 1940 the noteworthy Caproni Campini N.1 took to the air. The engine had been designed by propulsion engineer Secondo Campini, who interested Caproni in building an all-metal, two-place monoplane around a crude turbine powered by a piston engine. Though this early jet had a cruising speed of only 130 mph, it preceded by more than two years the initial flight of the United States' first turbojet, the Bell XP-59A.

Still, when you look up "Caproni" in the history books, it is inevitably the Ca 60 that is pictured. One Italian historian wrote that it "would not have looked out of place sailing up the English Channel with the Spanish Armada in 1588." Despite the burning of the Transaero's remains, the two wing floats and the bow survived and are on display in the Museo Caproni outside Milan.

—William Hallstead

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U.S. AIR FORCE

INVENTING THE SPYPLANE

RECON

THAT NEW BLACK MAGIC

When Lockheed and the CIA brought the U-2 into the world, it arrived in a cloak of secrecy.

by William E. Burrows

On Friday, November 26, 1954, Lockheed Aircraft's chief engineer, Clarence L. "Kelly" Johnson, called Edward Baldwin, Elmer Gath, and three other trusted engineers into his office, which was then at the Burbank Airport, near Los Angeles. Baldwin specialized in structures, Gath in engines. Starting the following Monday morning, Johnson said, they would be working on a project for the Central Intelligence Agency. It was so secret that the next 18 months to two years would have to constitute a blank spot on their resumes. Within eight months, Johnson said, they were going to build the world's first dedicated spyplane.

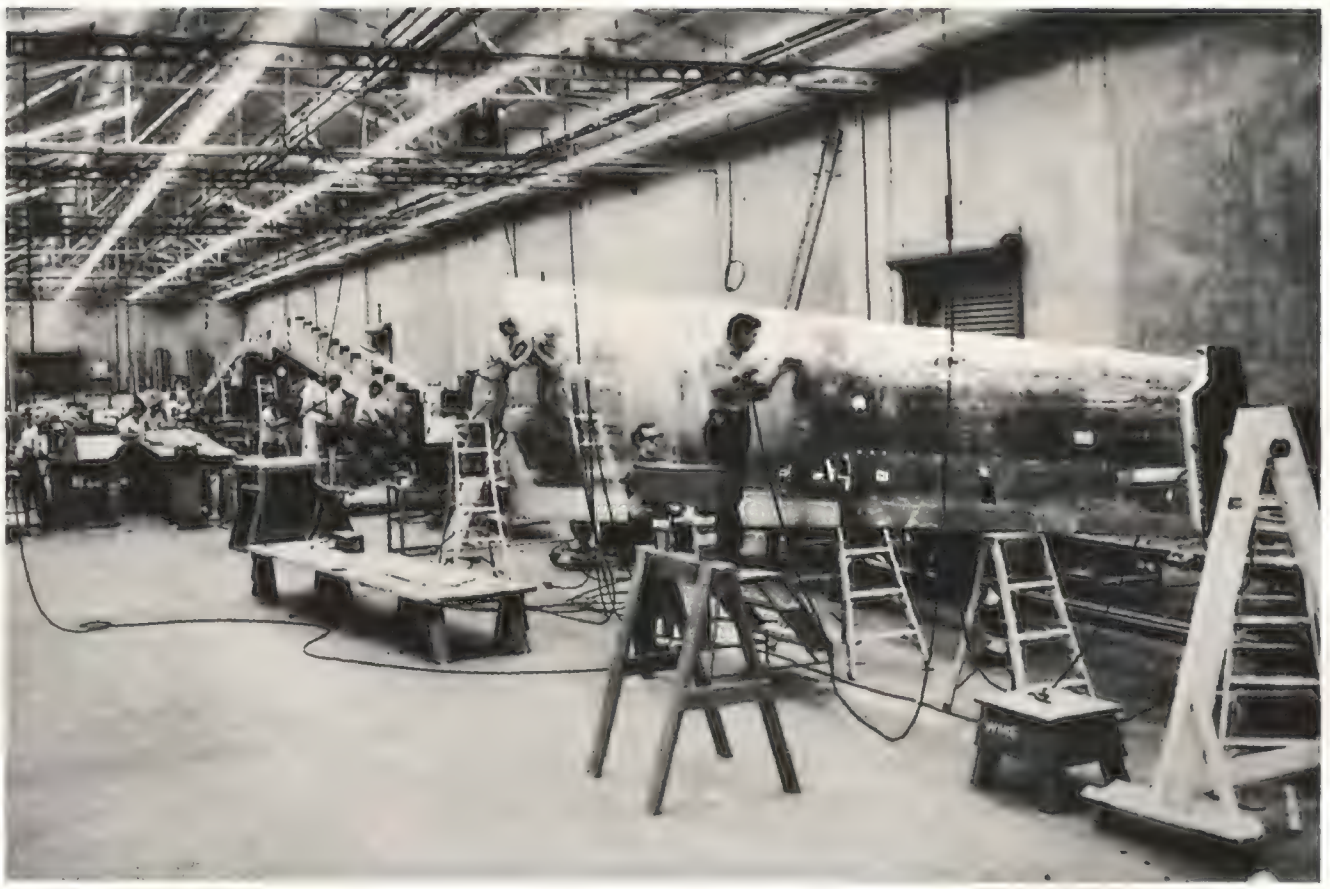
Even after World War II, the United States had gathered aerial intelligence by stuffing a fighter or bomber full of cameras and assigning it the prefix "R" for "reconnaissance." But in late 1953, the Air Force recognized the need for aircraft designed specifically to perform long-range aerial reconnaissance. The cold war had changed the military situation dramatically. Soviet nuclear weapons, ballistic missiles, and the economic and military structures that supported them were hidden behind a heavily defended curtain surrounding a landmass that spanned 11 time zones. The United States, fearful of a devastating nuclear surprise attack, was frantic

COURTESY CHRIS FOSCOLE

The world's first spyplane was borne to its Nevada desert test site in the belly of a Douglas C-124 Globemaster.

LOCKHEED MARTIN (2)

Among U.S. military jets, only U-2s have the unique sailplane-like form conferred by high-aspect-ratio wings that give the airplane its high-altitude capability. At the Skunk Works, designers and builders worked side by side (right).



to know what was going on. And the key to peering deep into forbidden territory was as obvious in the early 1950s as it had been in the Civil War, when the Army of the Potomac had launched observation balloons: You had to get up high.

In 1953 Bell and Fairchild had been invited to submit designs for an all-new high flier, while Martin was tasked with modifying the B-57, its version of the English Electric Canberra. All three were burdened with armor, systems, and heavy, high-G-tolerant structure, and Johnson knew that even a big wing could lift an airplane to 70,000 feet only if its weight were radically reduced. As an airplane climbs, its true airspeed increases in a linear manner until engine thrust begins to fall off. But *indicated* airspeed, which measures the force of the relative wind, diminishes constantly as the density of the air decreases in a long climb. At 70,000 feet, an airplane might be scooting through the air at an actual speed of 500 mph, but the pilot's airspeed indicator may register only about 125 mph—closer to the speed at which sailplanes cruise at lower altitudes. To the wing, it feels as if there's less wind, so it produces less lift and supports less weight.

When Johnson learned that the Air Force was soliciting three other companies for a high-altitude reconnaissance

aircraft, he submitted his own unsolicited entry, the CL-282. "First, we had to study the problem of what was needed," Johnson would recall when I interviewed him almost three decades later. "How far did it have to fly? How high did it have to go to get away from the fighters? How high did it have to go to get around the missiles? And having come up with our guesses in that category, we made a proposal to the Air Force to make this very lightly loaded, high-aspect-ratio vehicle that would fly over 70,000 feet and 3,500 miles."

The CL-282 was basically an F-104 Starfighter with exceptionally long sailplane-style wings. The ratio of the wings' span to the average width of their airfoil—their "aspect ratio"—would be high, which meant they would create very little drag at the wingtips for the amount of lift they produced, thereby ensuring long range and endurance. To minimize weight, the CL-282 had only one engine and flew without armor, pressurization, an ejection seat, or even landing gear. The airplane was so simple in concept that it suggested sublime Oriental understatement. The CL-282's ability to reach high altitude was also its chief means of protection: The best Soviet fighters could reach perhaps 45,000 feet—nearly five miles lower.

Despite the entreaties of a board of scientists and engineers led by Allen F. Donovan of Cornell, the Air Force flatly opposed the CL-282 and sent Johnson a letter rejecting it. "They proved conclusively" that what would become the most successful and longest serving spyplane in history was "impossible" to build, Johnson later said, with a triumphant smirk. Well, not exactly impossible; difficult, maybe. The Air Force strongly favored the Bell X-16, a twin-engine, armored, fully pressurized design, and the stretched-wing RB-57D. But Lockheed found a customer in the CIA and had the U-2 built and flying in time to cause the cancellation of the X-16. The RB-57D, at best an interim aircraft, flew some operational missions but was doomed by fatigue cracks in its wings.

Johnson's CL-282 had gotten a second chance. Under pressure from President Dwight Eisenhower and despite his own misgivings, CIA director Allen Dulles adopted the idea and assigned the project to Richard M. Bissell Jr. An economist from Yale, Bissell readily admitted that he knew nothing about aeronautics, so he turned the design and manufacturing operation completely over to Lockheed and put together a small, tight-knit operation that got things done quickly.

Having conceptualized the essential design, Johnson assigned about 50 engineers at the Lockheed Advanced Development Company, known by then as the Skunk Works, the task of filling in thousands of crucial details. He told Baldwin that he wanted 600 square feet of wing with an aspect ratio of 10 or 10.5 to 1. It wound up being 10.67 to 1. That meant the wing would be at least 10 times longer than its average width. The wingspan, which would come out to 80 feet, was so long that the wingtip ran off Baldwin's drawing board. "Are you sure you want a wing that looks like this?" Baldwin remembers asking Johnson.

"Yeah. That's about right."

"Well, I ran off the end of the board."

"Put a little patch of paper up there to show what it looks like," Johnson answered. "Then you'll have to redraw it because the blueprint machine won't handle anything wider than 42 inches."

Altitude would be the U-2's best defense, but altitude also constituted its single most difficult engineering challenge. Its engine, rated at more than 10,000 pounds of thrust at sea level, would produce only about 700 pounds of thrust at altitude. Hydraulic systems were heavy, so Johnson eliminated the customary hydraulic boost for the controls. To save time and cost, they used the bucket seat and the control yoke from a P-38. Some of the pilots recruited

UPI/CORBIS BETTMANN (2)

The CIA's Richard Bissell managed the program but kept a low profile (left). Kelly Johnson (with the XF-90, a rare Skunk Works stinker) knew he was racing against time as Soviet air defenses improved.

DWAYNE DAY COLLECTION

James Baker used German glass to create a U-2 camera lens with four times the resolution of contemporary cameras.

to fly the first U-2s disliked the yoke (which they associated with transport aircraft), but it took the strength of both arms to fly the airplane, and the additional leverage of the yoke was necessary.

Johnson saved even more weight by designing the airplane for load factors of only 2.5 Gs, a fraction of that for normal combat aircraft. Instead of using a wing spar that passed through the fuselage, the wings, which also carried almost the entire fuel supply, were simply bolted on. This would turn out to be an ingenious solution, for the airplane would spend little time in turbulent air. (At a CIA symposium on the U-2 in September, gleeful officials reported that a recent structural evaluation indicated the current airframe is good for over a hundred years' more service.)

And in his pursuit of weight reduction Johnson also eliminated landing gear. He wanted the CL-282 to take off from a wheeled dolly and land on its belly, which would act like a skid. But reality, in the person of flight test engineer Ernest Joiner, intruded. Joiner told his boss that the flight test program would quickly fall apart if the airplane had to have its belly repaired after every landing.

It was therefore decided to install a dual-wheel main landing gear and tailwheel in the U-2's fuselage and use flexible struts, or pogos, as they came to be called, to prop up the wingtips during takeoff, after which they would fall away. But that created another problem. The U-2's all-important payload, a very large, heavy camera, was to be carried in a so-called Q-bay behind the cockpit. The engine would be right behind the bay. The only place to put the forward landing gear was therefore between the engine's air intake ducts, which formed a pair of pants whose legs straddled the Q-bay. This was not the ideal place to put the forward landing gear, Baldwin says. It was too far forward and made landing somewhat tricky. But the engineers were stuck with it.

The engine was a modified version of the reliable Pratt & Whitney J-57, which powered F-100s and B-52s. But here, too, there were birthing problems. The P-31 version of the engine, specially adapted to high-altitude flying, was dedicated to another program for the Air Force. The P-37 version, the first U-2 engine, was not designed for altitudes above 65,000 feet. It therefore tended to flame out repeatedly above 57,000 feet. Pilots dreaded the prospect of having to descend to 35,000 feet, where the MiGs and missiles waited, to restart their windmilling engines.

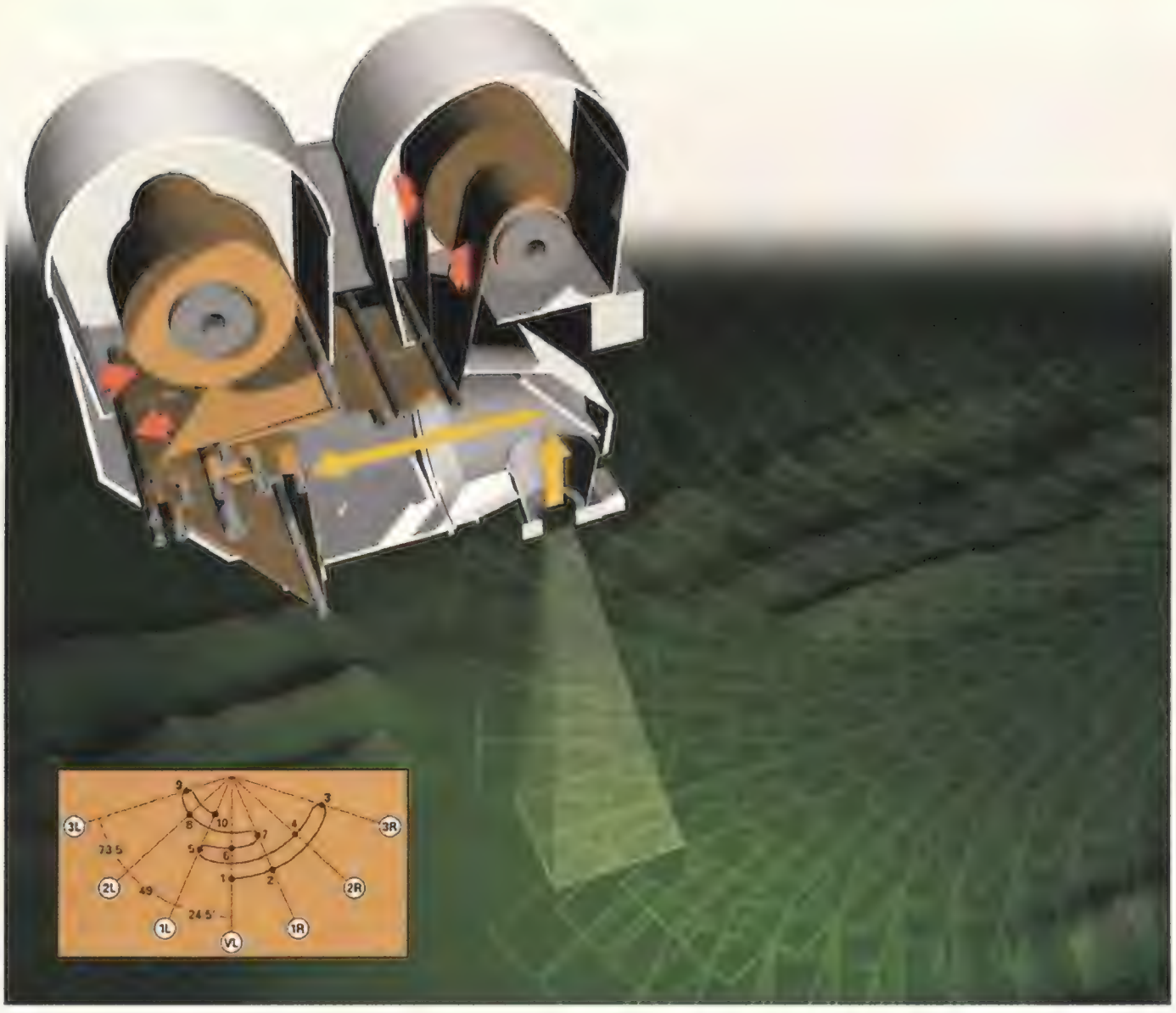
Then there was the oil problem. Because the atmospheric pressure at altitude was so low, oil leaked through the J-57's seals and got into the U-2's air conditioning and defogging systems. Engineers calculated that during an operational mission, 64 quarts of oil—the maximum capacity of the system—might be lost. The de-fogging ducts sprayed the windshield with hot air from the engine's compressor, and during long flights a gradually thickening coat of oil would form on the glass. This was solved by providing pilots with long sticks with diaper cloth attached to the ends so they could wipe the windshields clean. Someone even got the idea of welding a small metal box on the de-fog line and stuffing it with Kotex to absorb the oil. But the hot air was under so much pressure that it bent the box out of shape, says Lockheed's Bob Murphy, who was involved in many aspects of the U-2 and SR-71 programs. The problem ended only when the P-31 engine, which required less oil and was optimized for high altitude, replaced the model 37 in 1956.

Another worry was jet fuel: The standard JP-4 and JP-5 would boil away at high altitude. General James Doolittle, an executive with Shell Oil, had been a technical advisor to the reconnaissance community, and he persuaded Shell to develop a new jet fuel, designated JP-7, that had very low volatility. Production of JP-7 required most of the stocks of the petroleum products the company used to manufacture insect sprays, and although few Americans knew why, there was a nationwide shortage of bug spray in 1955.

In the near vacuum of the upper atmosphere, pilots also required special protection so that their body fluids would not bubble and boil. To this end, the David Clark Company of Worcester, Massachusetts, devised a partial-pressure suit, which was the first of its kind for keeping pilots alive in near-space conditions. This even led to the first specialized food and water provisions. Pilots could push a tube through a little hole in the face mask and suck on sweetened water or cheese- and bacon-flavored food mixtures squeezed from soft containers.

Undoubtedly the most daunting problem faced by U-2 pilots was the infamous "coffin corner," the terribly tiny margin between Mach-shock and stall buffet. At altitudes above 65,000 feet, the first U-2s had an interval of only six knots (7 mph) indicated airspeed between the onset of Mach buffet and a stall. In other words, the difference between the U-2's slowest flying speed and its fastest was only six knots. The

For more on the U-2, visit the Web at www.airspacemag.com/ASM/mag/supp/DJ99/U-2.html



JOHN MACNEILL

Captured on Film

Twin take-up and supply spools loop nine-inch film through the camera in opposite directions (the airplane's center of gravity never changes) to capture an image 18 inches square. Light passes through the shutter, then the lens, before caroming off a mirror set at 45 degrees in the swiveling head and striking the film. With the Q-bay partially pressurized, momentary vacuum pulses created prior to each exposure pull the ultra-thin film against a platen precisely curved to match the focal plane. The swiveling head follows one of several selected automatic sequences (inset) to capture overlapping images that provide stereo photo coverage from horizon to horizon.

margin was so narrow that Lockheed test pilots reported that in a bank, a U-2's inner wing could be stalled while its outer one was buffeting wildly from excess speed.

And as Ben R. Rich, the engineer who succeeded Johnson as head of the Skunk Works, said, "The shuddering felt the same whether it was because of flying too fast or too slow, so a pilot had to keep totally alert while making corrections." Once a U-2 pilot reached 70,000 feet and 400 knots true airspeed, he tried very hard to stay right there.

"The original U-2 was a difficult airplane to fly," says Garfield J. Thomas, vice president of Reconnaissance Systems at what is now Lockheed Martin. "It was a lot of work." Knowing that, the inventors of the revolutionary camera designed it to be automatic. "The pilot really had very little to do with the camera," adds Thomas. "The camera was usually preprogrammed and set up. When he reached a certain area, in the old days, he'd just throw a switch."

The camera itself was the result of a remarkable collaborative effort between Edwin "Din" Land, inventor of the Polaroid Land Camera, and James G. Baker, a Harvard-educated astrophysicist whose interest in optics went back to the 1930s. Land, a longtime member of the reconnaissance community's inner circle, led a group of presidential science advisors known as Project 3. In the U-2, he saw an airplane that could carry a camera good enough to count Soviet bombers and resolve the controversial "bomber gap," and it was Land who introduced the concept to President Dwight Eisenhower. Baker designed the U-2's camera, which carried a mile of specially developed, ultra-thin Eastman Kodak film. The film itself weighed around 300 pounds and had to be spooled on tandem nine-inch-wide rolls that fed in opposite directions on parallel tracks to maintain the airplane's center of gravity (see "Captured on Film," above).

The so-called Type B camera was fabricated by Hycon Corporation in California. Fitted into the Q-bay, which was

ERIC LONG

The Type B: film canisters on top (1), swiveling head with lens and mirror (2), and an electric shutter at its base (3).

LOCKHEED MARTIN

U-2s had interchangeable noses with different sensor packages for different missions. The cockpit (below) was dominated by an optical driftsight and a "transport" control yoke that pilots drawn from fighter squadrons disliked.

pressurized to 0.25 atmosphere (one atmosphere is a unit equal to the pressure of the air at sea level: 14.7 pounds per square inch), it was mounted on a hatch that actually formed a section of the skin of the airplane. The U-2 (and its supersonic successors, the A-12 and SR-71) would also come with noses that could be replaced with others carrying different sensors, the way lenses are changed on cameras.

Baker, now a gentleman of considerable years, still spends most nights doing experiments in his basement laboratory in New Hampshire ("Don't call before 10 a.m.," he warns). He credits Walter Pierstorff, the general manager of the Schott Company in Mainz, West Germany, with supplying "excellent optical glass of many types." And, Baker adds, there were "no questions asked." The result was a lens that could pick out a basketball from over 13 miles in the sky. The master optician recalls "jousting" with Kelly Johnson over how much space the camera was going to have and how much it would weigh. Johnson allowed him about 500 pounds.

Baker does not seem as impressed with his creation as the rest of the world is. The B camera, he says, was simply an evolutionary development arising from other work that went back to World War II. He is too modest. The best the older cameras could achieve was 20- or 25-foot resolution at 33,000 feet. At more than twice that altitude, they would be useless, especially for intelligence purposes, in which photo interpretation required 10-foot resolution. Baker's challenge was to design a camera that would be four times better than anything ever built.

Baker also had to meet Kelly Johnson's weight limits, so he replaced a heavy and bulky prism used to scan to the left and right of the airplane's course with a single mirror mounted within a swiveling housing. The assembly followed an automatic sequence to capture overlapping images of a swath of ground that stretched from horizon to horizon.

For the pilots, the airplane was a handful to fly, uncomfortable for many hours, and although initially out of reach of Soviet weapons, that small luxury would not last long. To make it less visible, additional measures were tried. The first, and most obvious, was a flat, midnight-blue paint scheme to match the dark sky. It actually didn't blend all that well, but dark blue was better than polished aluminum, which had led to reports of lights in the sky over the Nevada desert where the U-2 was first tested. ("Pastels are the best stealth colors," Ben Rich once observed, "but real men don't fly pink jets.")

Another technique involved swathing the underside with a metallic grid called a Salisbury Screen, then covering it with black foam rubber to capture and dissipate radar microwaves. The third technique, tested in a program aptly named Dirty Bird, called for adding metal "standoff" posts from tail to nose and connecting them with wires set at precise distance from the skin. MIT's Lincoln Laboratory said

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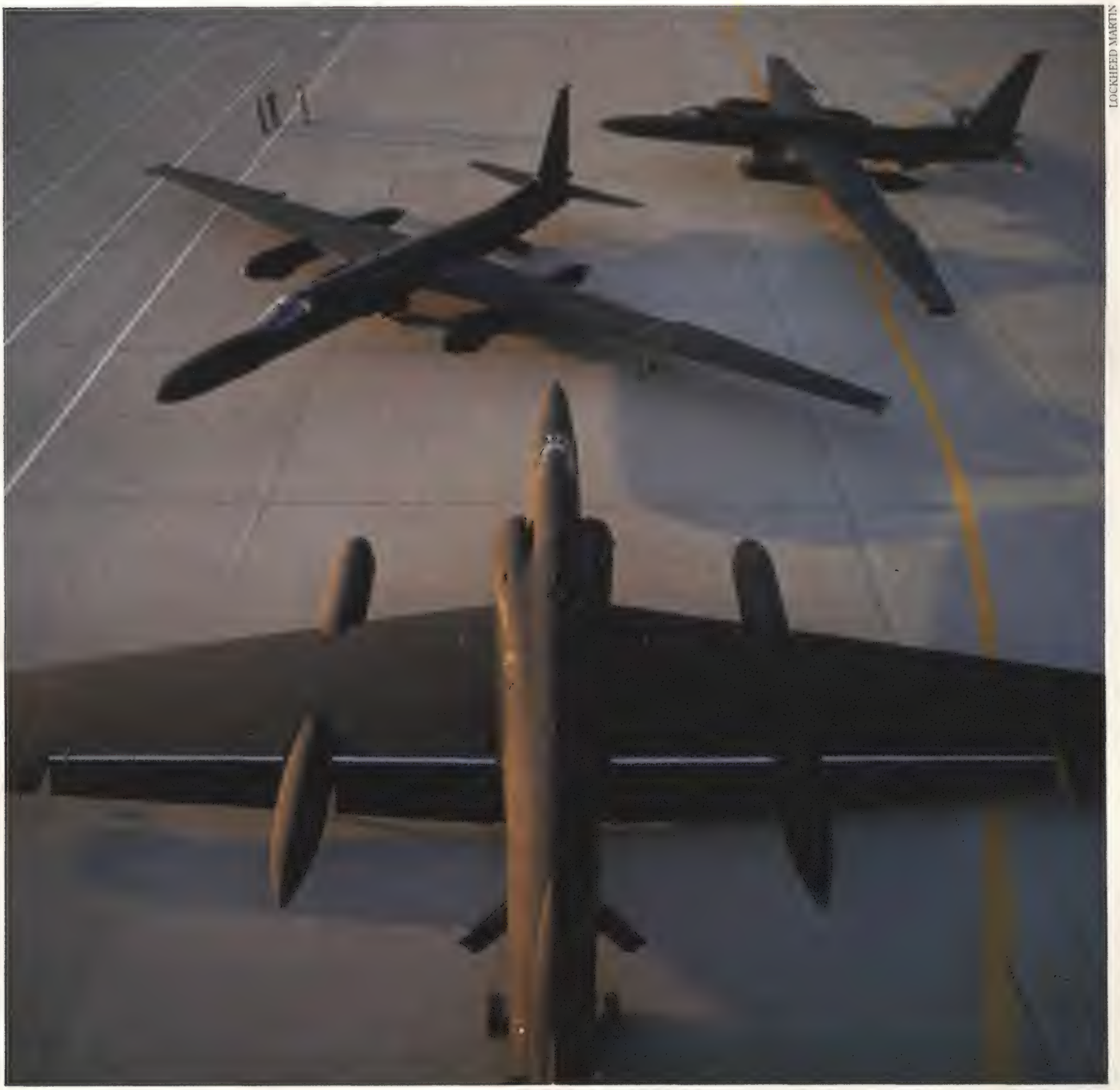
the wires would cancel or scatter the radar energy reflected off the skin. Neither scheme worked, but the posts were especially disastrous. Some wires snapped during flight tests and lashed the aircraft like whips. More important, they cut the U-2's performance so badly that they nullified the reason for building it. "They went out and flew it," recalls Garfield Thomas, "and it was so draggy they would never get to altitude and never have any range." Rich said simply, "They made it look like a rake."

Even before the U-2's first missions, in June 1956, the CIA worried that its operational life over the Soviet Union would be no more than two years because of rapid improvements in Soviet air defenses. They were wrong; it would be nearly four years before Francis Gary Powers was downed. The airplane designated with a lowly "U" for "utility" to hide its true purpose would enter Air Force service in 1957, photograph Soviet missiles entering Cuba, and, in the hands of Nationalist Chinese pilots, penetrate the People's Republic of China. Today it flies frequent missions over Iraq in support of the United Nations' surveillance of that nation's efforts to produce weapons of mass destruction. But it was the knowledge that a U-2 would eventually get nailed that drove Kelly Johnson to invent its high-flying supersonic replacement.

In the next issue: Inventing the Blackbird →

Current U-2 models carry additional payload in wing-mounted pods. The airframe could fly a hundred more years.



LOCKHEED MARTIN

Rod Diehl, a member of the author's ultralight club, gets a splendid view of Hanover County, Virginia, in his one-cylinder-powered Weedhopper. The craft meets all FAA requirements for the category and is thus one of the club's few "true" ultralights.

Flying at the fringes of aeronautic respectability.

Story and photographs by Tim Wright

The flickering movie footage is overexposed and washed out. What looks to be a delicate-looking biplane comes rushing toward the camera with a man running alongside, his hand steadying one of the two lower wings. As the craft passes, the camera reveals another man running between the lower wings. The fabric-and-wire craft, powered by a crude little engine, reluctantly stumbles into the air, carrying the second man with it. Never rising more than a few feet, it staggers a hundred yards or so, then plops back to earth.

John Moody hits the stop button on the VCR and turns to his audience. "Kinda reminds you of the Wright brothers' first flight, doesn't it?"

Moody's comparison is both apt and ironic. In his early 50s, the small trim man with the harmless demeanor is to many a father of aviation. But to others he created an aeronautical nightmare. Everyone agrees that he gave birth to aviation's *enfant terrible*: the ultralight.

In the early 1970s, Moody, then an engineer, learned of an $86,000 prize being offered by British industrialist Henry Kremer to the first person to achieve human-powered flight. In a quest for the prize, Moody first turned to the hang glider.

Like a kid describing favorite vacations, Moody entertains his audience with stories of his trials and tribulations. He describes dashes up and down the low hills of Wisconsin with his glider, encounters with fences, and summertime leaps from the cliffs and dunes along the Great Lakes. But from dozens of glider flights, he got less than 15 minutes' total flight time.

Moody began experimenting with small two-stroke engines, like those

used in chainsaws. Others had tried to boost glider performance with engines—some had strapped an engine on the back of the pilot, or attached one to various parts of the glider itself—but none of the schemes had enabled the pilot to take off from flat terrain in no-wind conditions and climb. Moody attached his engine to the inside rear struts of a hang glider called the Icarus II, which looked like the wings of an early biplane, only swept back. The configuration worked. And as he refined the integration of hang gliders with engines, his involvement in human-powered flight waned.

Word of Moody's new aircraft spread quickly. Hang glider pilots saw the innovation as a giant leap forward because the small engines allowed them to defeat the dead calms that kept them grounded. Ultralights, as powered hang gliders quickly became known, had just enough power to lift themselves and the flier to where he or she could find rising columns of air called thermals. Once these invisible elevators were found, pilots could shut down their engines and soar like any other glider.

Unfortunately, many of the early designs had safety problems; according to Moody, when the owners damaged their craft, they didn't always repair the damage adequately. Worse, because ultralights were not initially covered by Federal Aviation Administration regulations, people with no flight training of any kind were teaching themselves to fly. The FAA felt the need to take action. In 1982, it issued Part 103 of the Federal Aviation Regulations.

The regulations stated that, in addition to adhering to the same rules the agency imposed on general aviation flying, ultralight pilots cannot fly at night, in clouds, or over cities or towns. Furthermore, the rules included a definition of ultralights: an aerial vehicle that could not exceed an empty weight of 254 pounds, a fuel load of five gallons, a maximum full-power level-flight speed of 63 mph, and a passenger load of one. Surpass any of those limits and in the eyes of the FAA the ultralight becomes an airplane and all corresponding rules and regulations apply.

Powered parachutes (top), which cruise at a sedate 25 mph, are now one of the most popular ultralight varieties. The Fisher FP-303 above was decked out like one of the P-40s the Flying Tigers flew in World War II. Below: ultralight luminary John Moody takes off at Sun 'N' Fun in an Eagle XL.

In recent years, ultralight pilots have been adding equipment that increases the weight of their vehicles, sometimes beyond the legal limits. At the same gathering of ultralight pilots where Moody showed his films, an FAA official (present on an unofficial basis) glared at the audience and declared: "Ninety-five percent of all ultralights are illegal. They're too fat, too fast, and they're carrying too much gas. Are you gonna argue with me?" The silence confirmed one of the worst kept secrets in aviation. In general, most ultralights exceed most restrictions. I belong to a club of ultralight pilots, and of the dozen or so aircraft we own, only one or two meet the legal definition of an ultralight.

Pilots justify the excesses by claiming that many of the additional features now available—landing gear, flight instruments, brakes—enhance safety. And they add that the current rules are

outdated and need to be overhauled. The U.S. Ultralight Association wants the FAA to recognize a standard already adopted by the international ultralight organization, which allows slightly heavier, faster aircraft that can carry two passengers and 10 gallons of fuel. The FAA has been studying these recommendations for 10 years and has periodically issued exemptions, allowing certain groups to operate multi-seat craft for training purposes. But to the frustration of many, the agency has yet to permanently redefine the ultralight.

A good place to take in the diversity of ultralights flying today is the annual Sun 'N' Fun airshow, held each year in Lakeland, Florida. Last year, I attended with some fellow members of the Central Virginia Ultralight Club. We stayed for five days. At the end of each day, we settled in at the parking lot at the end of the grass ultralight runway. Footsore and sunburned, we sat outside our van, popping beers and watching ultralights fly in the failing light. Aircraft took off and landed in a constant procession, reminding me of fashion models strutting up and down a runway. In a single glimpse one could spot all of the ultralight varieties: the airplane-like type, the "classic" lawn-chair-under-wing, powered parachutes, amphibious powered parachutes, powered paragliders, powered hang gliders (better known as "trikes"), and hybrids that combine two or more types.

One afternoon, John Moody, the man who started it all, took to the air in the ultralight equivalent of a Model T—an Icarus II descendant called the Easy-Riser—to join a dozen or so of his aviation offspring. When his engine sputtered and quit shortly after takeoff, conversation at the van stopped and all eyes turned to watch Moody deal with the Great Truth of ultralight aircraft: It's not if your engine quits, it's when.

Moody used the same technique general aviation pilots use in this situation: He lowered the nose of his craft, maintained airspeed, and made the most normal landing he could in a nearby field.

Novices can learn how to handle such predicaments by taking lessons from instructors trained by the U.S. Ultralight Association. However, ultralight fliers aren't required to take any kind of instruction whatsoever. Nor do they need to earn a pilot's license, or pass a flight proficiency or medical exam. (The lack of a medical certification requirement may be one reason that ultralight pilots are more likely to be grandfathers than testosterone-crazed young Turks.)

While at Sun 'N' Fun, I talked with a few general aviation pilots who harbored some doubts about the skills of ultralight pilots. Bill Deane, who flew to the

Mix and match: Russian pilot Yakov Sabodin, who flew a MiG at Sun 'N' Fun, tries on the harness portion of a powered paraglider (above). At right, a formation of Buccaneer amphibians and a Zephyr land-based ultralight (second from bottom)—stage a demonstration flight.

Above: Tony Anderson attempts (but fails) to take off in a Quicksilver MX with inflatable floats. The craft can take off and land on grass that is wet enough to be slippery. Left: A pilot prepares to land a Keuthan model with a heavy fiberglass fuselage.

airshow in his Beech Bonanza, said he worries that some may not have had the training to fly safely around airports. Still, Deane included himself when he added: "I don't think there's a regular [general aviation] pilot who hasn't thought that ultralights aren't an option down the road," such as when he or she is denied a medical certificate.

After a week of talking, walking, and watching at Sun 'N' Fun, we headed home to Virginia. I sat in the back of the van we'd come down in, making a place for myself among aircraft parts and bags of potato chips. The Florida sun was climbing above the horizon, filling the van with light.

As we headed down the highway, I got to talking to one of my fellow club members, Bobby Clarke. Bobby comes from a family of airplane folks. His parents began selling fuel to the airlines and chartering aircraft at Richmond's Byrd Airport 50 years ago. He has a huge hangar of single- and multi-engine aircraft to choose from, so I asked him why he flies ultralights.

"It's the most fun flying I have ever done in my life," he said. "It's addicting. It's so much fun, I have to force myself to stay current in my company airplanes."

It's also a lot cheaper than flying airplanes: A new four-passenger Cessna 172 (the most popular mid-size automobile of general aviation) starts at $133,000, while a top-of-the-line ultralight goes for $18,000. And the owners can do all the maintenance themselves, instead of having to pay for annual servicing by FAA-certified mechanics.

In short, you don't have to be in the country club set to fly ultralights. In our club, which I gather is pretty typical, we have an electrician, a factory worker, a steel worker, a nuclear engineer, an aircraft mechanic, computer geeks, and a car salesman. We meet in the cobbled-together house-trailers that make up our clubhouse at Holly Spring Airport, a grass airstrip nestled among the pines and rolling countryside of the Virginia piedmont. The room has an old pool table, and a coffee can hangs from the ceiling to catch leaks.

One afternoon, Richard Moore, a pilot from a neighboring club, offered me a ride in his Max Air Drifter. It's too heavy to meet the legal definition of an ultralight, but Richard has registered it with the FAA as an airplane and he holds a pilot's license, so we were completely legal as we bounded off a grass strip and climbed into the cool fall air.

We cruised along at 1,500 feet with a 65-mph wind blasting our faces. With no doors, roof, or floor, there was nothing but Richard's considerable girth to block the wind, and I was quickly chilled to the bone. But I could take in the Chesapeake Bay to the east, the coastal plain to the west, and the brown fields of autumn directly below.

Right: Wray Bragg, another member of the author's club, once flew this one-cylinder Thundergull from Southern California to his home in Virginia. Bragg began flying ultralights when he lost his medical certificate. Below: Sheldon Early flies his Flightstar over the Shenandoah Valley in Virginia. The cylinder just behind him is a ballistic parachute that can be deployed in an emergency.

Both seats have controls, and after a while Richard graciously turned the piloting over to me. I began banking us through one turn after another. Through the wires strung beneath the wing, I watched the earth below spin and blur. In many ways, I realized, ultralights have brought aviation back to the days of the Wright brothers, and the common man back to the skies.

NANCY ALLISON WRIGHT COLLECTION

COURTESY JACK FOLZ

Allie's Choice

by Nancy Allison Wright

Captain Ken Colthorp had come back into the cabin of the airplane to check on his three passengers: his wife, my mother, and me. "Do you see those puffy little clouds below us?" he asked me. I peered out the window and nodded. "The Communists are firing at us," he said.

It was December 16, 1948. That October, Chiang Kai-shek had lost 400,000 of his best troops at the battle of Shenyang (formerly Mukden), a massive defeat that marked the turning point in China's Communist revolution. By November, the Red Army had occupied Suzhou (Hsuchow), the currency had collapsed, and Chiang had hurried to complete the transfer of his Nationalist government to Taiwan. My father, Ernest M. "Allie" Allison, then operations manager of China National Aviation Corporation, moved the company's main base from Shanghai to Hong Kong, and my mother and I were evacuated in a CNAC C-46. We left everything but two suitcases behind.

CNAC was China's largest airline, jointly owned by Pan American Airways and the Nationalist Chinese government. I didn't know at the time that my father would attempt to save it for the very people who were shooting at us. I was 11 years old and didn't understand much about the civil war that surrounded us or Dad's plans for the company.

After we arrived in Hong Kong, Moth-

To Ernest Allison, the Chinese were neither Communists nor Nationalists. They were potential passengers, and he wanted to give them an airline.

After Mao's victory, China National Aviation Corporation workers painted the Communist flag on their aircraft (opposite). The author's father, CNAC executive Ernest Allison, shown here with an unknown passenger, supported their wish to keep the airline in China.

er and I settled into a two-room suite at the Hotel Miramar in Kowloon while Dad flew back and forth to Shanghai, evacuating equipment and personnel. In the first week of our arrival, Quentin Roosevelt, CNAC's 30-year-old vice president and a dear friend of our family, was killed in an airplane crash. Dad, as the new vice president and director, shouldered almost all the responsibility for guiding the airline through the critical period that followed.

NANCY ALLISON WRIGHT COLLECTION

During the next six months, my father spent much of his time in Shanghai, wrestling with the uncertainties of CNAC's future after Mao's imminent takeover. That city fell to the Communists in May, and the following month, as Nationalist forces blockaded by sea and air all China's Communist-held coastal cities, my mother and I boarded the *President Taft*, a ship bound for San Francisco. We planned to spend the summer at our home in Arcadia, California, and return to Shanghai in the fall, when, as Dad said, "matters settle down there."

Matters didn't settle down. On October 1, Mao proclaimed the birth of the People's Republic of China, and CNAC's future remained as uncertain as ever.

Back in the United States years later, when I was an adult with a family of my own, my father and I talked about those times. In many of our conversations he told me that Mao had asked him to come to China and run the airline for him. What he didn't tell me was that he had accepted. It wasn't until after he died at age 81 that I learned he had decided to operate CNAC for the Chinese Communists. I found out by interviewing the historians who had so many times interviewed him. I also read his diaries, letters, and logbooks and searched through public archives to try to understand my father's role in CNAC's controversial last days and find out how he came to make the choice that caused many people, some of them his friends, to question his patriotism.

Dad had helped build CNAC into the largest airline in East Asia. It operated 60 aircraft—six DC-4s, the rest twin-engine C-46s and DC-3s—to 33 Chinese cities. The airline established routes to San Francisco, Bangkok, Rangoon, and Calcutta, and was about to initiate one to Tokyo when it was engulfed in China's civil war.

Although CNAC was China's flagship carrier, it was not the country's only significant airline. Central Air Transport Corporation, owned wholly by the Chinese government, served 26 cities in China. And Civil Air Transport, owned by Whiting Willauer and General Claire Lee Chennault, the former head of the famed American Volunteer Group, better known as the Flying Tigers, flew daring support missions as a paramilitary arm of the Chinese air force.

Dad's history with CNAC dated back to its founding in 1929 when, as a U.S. Air Mail Service veteran with 8,000 hours in Curtiss Jennies and de Havilland 4s, he signed on with the fledgling China carrier to survey and inaugurate its first routes. At the time, CNAC was owned by the Chinese Nationalist government and the Curtiss-Wright Corporation. In 1933, Pan American Airways bought Curtiss-Wright's interest.

Flying Loening Air Yachts, Dad and his fellow pilots pioneered a civil air network along China's lifeline, the Yangtze River. The Loening amphibians, powered by single 525-horsepower Pratt & Whitney Hornet engines, could each carry a thousand pounds of freight and six passengers. They cruised at 100 mph. "When visibility became poor, we landed on the river and continued on the step [with floats on the surface, ready to lift off] at about 40 mph under reduced power," Dad wrote in a memoir. "When visibility improved, we simply opened the throttle and took off."

The Sino-Japanese war forced our family out of China in 1939, but we returned in 1947, after William L. Bond, then CNAC operations manager, pleaded with Dad to come back and untangle problems in the airline's operations department. Following World War II, the airline had shifted from a cargo carrier to a full-service airline, and it was suffering from inadequate ground facilities, labor problems, and growing pains. Then the Communist revolution disrupted operations almost entirely.

I learned that as Dad shuttled back and forth between Hong Kong and

FROM *THE DRAGON'S WINGS*, BY WILLIAM LEARY JR.

Ministry of Communications DC-2 with the Chiangs aboard, the plane's electrical system failed, forcing him to return to Hankou. Flying without landing lights and with no lights on the airfield—and avoiding bombs placed on the runway to destroy it before the Japanese arrived—Dad set the craft down. With the government plane out of commission, he prevailed on CNAC to take the Chiangs on the next leg of their scheduled flight. That night CNAC pilot Charles L. Sharp and Dad flew the stranded party to safety. "We both had been flying for several days and nights taking government officials out of Hankow to points west and were exhausted, so we took turns flying while the other slept," Dad wrote in one of his letters.

Shanghai, galloping inflation, which at one point doubled the price of rice in one day, proved a terrible burden to CNAC's Chinese workers. "One day I was mobbed twice by our own mechanics," Dad told a reporter for the *North China Daily News*, an English-language newspaper in Shanghai. "Once at Lungwha [Shanghai's airport] about noon and that evening at our downtown office. It took several Americans and loyal Chinese all armed to get me out of my office. That evening Mayor K.C. Wu sent a machine gun squad to our downtown office to disperse the crowd so we could go home."

Also among his papers, I found an English translation of a bulletin circulated among the CNAC employees in Shanghai in May 1949, a few days before the city fell to the Communists. "You have two choices, either stay and protect your property or leave the land of your forefathers and go into exile as white Chinese," it read. The bulletin must have been distributed by employees won over by the Communists.

To many CNAC employees, including, I think, my father, the choice was not between two governments but between keeping the airline going or abandoning it. As the Communists gained territory, they appeared more able to support an airline than the weakened Chiang. And yet Chiang Kai-shek had been a great friend to CNAC. Many times, both as a child and as an adult, I'd heard my father talk about his relationship with the Chiangs. He credited them with China's gradual acceptance of air travel.

NANCY ALLISON WRIGHT COLLECTION (2)

He prized a sterling silver martini shaker engraved with a dragon that he had been given when he had been employed by the Nationalist government as an advisor to the Commission on Aeronautical Affairs. The inscription read: "Christmas 1938, from Generalissimo and Madame Chiang Kai-shek." The gift acknowledged Dad's effort on the night of October 24, 1938, to evacuate the Chiangs from Hankou (Hankow) as Japanese troops invaded.

That story was one of the most repeated tales in our family collection. It went like this: After Dad took off in a

My father felt an allegiance to the Chiangs, but he also felt a sense of obligation to the Chinese managers and pilots with whom he worked. And while Mother and I waited for the signal to come back to Shanghai, he confronted a situation that turned critical the morning of November 9, 1949. The night before, CNAC managing director Colonel Liu Ching-yi asked Dad and operations manager James H. McDivitt to join him for a breakfast meeting in a downtown Hong Kong restaurant. While Dad and McDivitt settled themselves at the table, awaiting Liu's arrival, 10 CNAC and two CATC airplanes took off from Kai Tak for mainland China. On board one of

them was Colonel Liu. (One of the CNAC airplanes turned back to Hong Kong with engine trouble.)

Liu had been a family friend. (My diary shows that shortly after we arrived in Hong Kong, he brought me my radio from Shanghai and a few gifts as well: a silk dress, a handkerchief, and a doll.) Immediately after his defection, he sent a letter to my father inviting him "to come immediately to Peking for an emergency meeting of the Board of Directors." In his letter, dated November 9, 1949, he also defended his decision. "CNAC is an airline of China which cannot live off the China land nor can it stay in a foreign hide-out," he wrote. "It must go back to China and resume operation in China."

Fred Chin, a CNAC Chinese pilot who flew back to China on that fateful November morning in 1949, today lives in Monrovia, California, and remembers the decision he made. The "Communist underground," he says, promised he'd receive the same position, same salary, and same living standard he'd enjoyed in Hong Kong. "I was only 25 years old," he says. "The way we see it we only want a job and fly, that's all. I'm a Chinese. I'm not a Communist." Chin says the "kind of government" was of no consequence to him, "as long as I can fly."

CNAC copilot Chu-xioang Zhou, today a tai chi instructor in Everett, Washington, remembers Communist agitators telling him: "China is so big you guys can fly just like before. And you can fly all the time—no foreigners, all Chinese."

This would have been an important promise to the Chinese pilots, who were paid less than the U.S. pilots who flew for CNAC. Even pilots of Chinese descent born in the United States were paid less than the white pilots, and my father and other CNAC managers had been confronted repeatedly about the unequal treatment.

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"We wanted the country to be united," Zhou says. "We didn't know the Communist party. We thought that it must be better than Kuomintang [the Nationalist political party]. We were happy even to lose everything. But now we look back we sacrificed too much because freedom is everything. Once you lost freedom, it's more important than anything else in the world."

Both Zhou and Chin suffered persecution after returning to China from Hong Kong. Having been educated in the United States, they were pegged "rightists" and sent to labor camps in the countryside.

Not all of the Chinese pilots in the company defected. Moon Chin, an American-born Chinese who had transferred from CNAC to CATC, where he became vice president, wanted nothing to do with Communism. "I want to keep what I earn and other people should keep what they earn," he says. "No equal treatment." To avoid the situation, he simply took a leave of absence from the company and, as he says, "let them do what they want because I was gone."

The day after the mass defection, Pan Am and CNAC officials and employees gathered at the Peninsula Hotel to discuss moving the airline to mainland China. CNAC was flying diminished route schedules to fewer and fewer Nationalist-held areas, and William Bond (then a Pan Am vice president) had informed the U.S. Department of State months earlier that Communist officials had invited Pan Am to continue operating CNAC within China. At the meeting two views emerged. As James McDivitt wrote in a letter to me a few years before his death in 1997: "One group was adamant in their statements that they would never go to work for a Communist government under any consideration." The other group, which, ac-

Allison helped get CNAC on its feet in the early 1930s by pioneering cargo routes along the Yangtze River (opposite). The airline inaugurated trans-Pacific service between Shanghai and San Francisco in 1947 (above). Its first DC-4 arrived in Shanghai's Lungwha airport the year before.

NANCY ALLISON WRIGHT COLLECTION (3)

Before World War II, Allison and a small group of pilots operated CNAC's mail and passenger service with Douglas Dolphin amphibians. Opposite: After the war, the line grew, and employees took pride in the airliners the company acquired, including the C-46 Air Prince.

cording to McDivitt, included Dad and Bond, believed the company should enter negotiations with Mao's government. They felt, McDivitt wrote, "That a wonderful opportunity existed for Americans to get legally behind the Iron Curtain and begin to hopefully prove to the world that working together was possible."

My father almost certainly espoused these principles, but it is difficult to know, after so much time has passed, whether they are what guided him in his attempt to work with the Communists. He wrote to my mother only that "two factions in CNAC are tearing it apart." Historian William M. Leary Jr., author of the definitive history of the CNAC, *The Dragon's Wings*, had corresponded with Dad for years and has a different interpretation of his motives. "Your father supported becoming partners with the Communist government," he told me. "He thought of Mao as just another warlord." According to Leary, Dad failed to understand the "diplomatic ramifications" of partnership with a Communist regime, a proposal which "got shot down at the highest political levels." Leary called him tough but politically naive.

I think I came closest to the truth in my correspondence with 75-year-old Beijing professor Renjie Hua, the executive vice president of the Beijing Aviators Association, who was a CNAC copilot and later air traffic controller. After the revolution, he joined the People's Liberation Army bomber division, eventually becoming a research officer in the PLA Air Force Command College. "Your father supported the idea of taking the airline back to mainland China in 1949," he wrote. He spoke on my behalf to 83-year-old Gordon Poon, also now living in Beijing. Commanding a CATC Convair 240, Poon was the one pilot who flew to Beijing back in November 1949. The others landed in Tianjin (Tientsin). Premier Zhou Enlai gave Poon a hero's welcome on his arrival, and a month later the airplane was christened *Beijing*. Hua wrote that Poon, who'd once flown for CNAC, remembered Dad: "Many Chinese pilots were checked out by him, so most of CNAC Chinese pilots knew him and were grateful to him."

I think my father's openness to the Communists was based more on this relationship with the Chinese pilots than on his political beliefs. These men and Dad had shared the experience of building a company, and they also belonged to the sort of brotherhood that forms around airplanes. Dad was an able businessman, but he was more comfortable in a leather flight jacket than a three-piece suit. Fred Chin expressed it best: "as long as I can fly."

This is of course a daughter's perspective. But understanding Dad's decision as a personal one as much as a professional one, I can see even more clearly why the events that followed were so painful for him.

After the meeting at the Peninsula Hotel, Dad called a press conference in Hong Kong that, McDivitt remembered, became "extremely unruly." My father told one of the Hong Kong reporters that CNAC's fate lay in the hands

of the Chinese people and that CNAC's 37 U.S. pilots were "solidly behind the company." Journalists hammered him with questions about whether he would really work for a Communist government. "Our loyalty lies with the company, regardless of ownership," he answered.

While the events in China were being reported in U.S. newspapers, Rear Admiral Roscoe H. Hillenkoetter, director of the CIA, leveled charges within the agency that CNAC's American partners "were fully aware of the deal [defection] and lent their support." My father has always denied this accusation. He wrote to my mother shortly after the defection: "Liu jumped the gun" and later, "None of the Americans, including myself, knew it was going to happen." Public indignation peaked with the publication of a *Time* magazine article that erroneously reported that "eight American pilots had already gone to work for the Communists." (Among Dad's papers, there is even a letter about the article from his mother in Sterling, Kansas. She wrote, "I did not think you'd do business with the Communists.")

The news that U.S. airline executives and pilots were considering working for Red China made headlines at a time when anti-Communist fervor was at its peak in the United States. In January 1950, just two months after the news stories appeared, former state department official Alger Hiss was convicted of perjury after journalist Whittaker Chambers accused him of membership in a Communist espionage ring. At the same time, Senator Joseph McCarthy launched his investigation of Communist infiltration of the state department.

In fact, the state department, at the time my father was trying to hold things together in Hong Kong, was not at all receptive to the Communist government (the United States did not recognize the People's Republic of China for another 29 years) and was very cool to Pan Am's proposals of becoming partners with the Communists. On December 15, 1949, Deputy Assistant Secretary for the Far East Livingston Merchant told William Bond and another Pan American vice president, Harold Bixby, that the department's "attitude throughout had been that the disposition of CATC and CNAC as Government-owned corporations lay in the hands of the Chinese Nationalist Government and that we would naturally greatly prefer to see those aircraft remain in the hands of the National Government and not fall into Communist hands." Although Pan Am had been seeking the department's position since June 1949, it wasn't until December that the company received a "draft response" stating the department "would prefer to see Pan American Airways disassociate itself from any connection with CNAC...as rapidly and as completely as its contractual obligations... would permit."

Why the hedging and delays? Many historians have pointed out that the Truman administration, though strictly anti-Communist, feared Moscow more than Beijing. Any discussions among policymakers that could be construed as even mildly accommodating toward Communist China were directed toward keeping the Chinese from being completely dependent on—and therefore completely loyal to—the Soviet Union. But the administration did accept the inevitability of the Communist victory and virtually ended military aid to the Nationalists in 1949.

To clarify this decision, President Harry Truman issued to Congress—and on August 5, 1949 released to the public—Secretary of State Dean Acheson's thousand-page report, *United States Relations with China,* which became famous as the China White Paper. The report, which asserted that Chiang had been undermined as much by corruption in his own government as by Communist aggression, was reviled by conservatives, who accused Truman of betraying an ally and being soft on Com-

munism. And so the administration yielded to the so-called China Lobby—politically influential Chiang supporters, like publishers Henry Luce and Roy Howard, columnists Joseph and Stuart Alsop, General Claire Chennault—who argued for postponing trade and diplomatic talks with the emerging Communist regime.

By the time the state department was deciding how to advise Pan Am, however, CNAC's Chinese staff, sympathetic to Mao, had taken possession of the airplanes remaining in Hong Kong. The Nationalist government withdrew airworthiness certificates for the aircraft, in effect grounding them, and the Hong Kong authorities announced that no airplanes would be permitted to depart Kai Tak without proper registration. Then a bomb dropped.

General Claire Chennault announced that he, his partner Willauer, and four other investors had bought both CATC and CNAC from the Nationalist government. He had persuaded Chiang to sign over the airlines to him, saying he could head off Communist claims for ownership and eventually transfer the planes to Taiwan. Chennault cited intelligence reports that the Chinese Communists were training paratroopers for an assault on Taiwan.

Chennault's move astounded my father. "Chennault and Willauer are trying to steal our assets," he wrote home. The two men had known each other since 1918, when they had both served in the U.S. Army Signal Corps at Kelly Field in San Antonio, Texas. Dad was a flight instructor and Chennault a fledgling pilot whose erratic behavior and unorthodox flying techniques threatened to get him dropped from the corps. The Army washout board assigned Dad to take the flamboyant Louisianan up for one last-chance flight. After an hour's ride, Dad landed and signalled Chennault to fly on by himself. He wrote in his report: "This man can be taught to fly." Chennault wrote in his autobiography, *Way of a Fighter*: "To Allie I owe my first glimpse of the kind of flying that really made me love the air."

The two renewed their friendship in 1938 in war-torn Hankou. At the time, Chennault was laying plans for the AVG to fight Japanese invaders, and Dad was directing the development and maintenance of airfields for the Nationalist government. Whenever Dad was in Hankou that year, they roomed together.

"I can imagine the feeling you must have if you turn your pet over to him," Mother wrote in 1949. That Christmas Dad received a card with the curious message: "From your good, altruistic friends, Chennault and Willauer."

Dad, as well as Pan Am president Juan Trippe, questioned how the Nationalist government could sell China's flagship airline without the knowledge of Pan Am, a 20 percent owner. (A clause in the airline's contract prevented one partner from selling without the other's approval or selling to a private individual.) What Dad and Pan Am executives didn't realize was that Chennault had the backing of a powerful ally: the Central Intelligence Agency.

It took me years of research into CIA and state department files before I pieced together the facts. Eventually, I learned that a short time before the defection, Chennault sold CAT, then financially ailing, to the CIA. State department officials told Pan Am executives to back off. "The Communist factor overrides all business considerations," they wrote in a memo. The agency advised them to see "certain CIA people."

Dad fought the sale to the end. Tillman Durdin, a *New York Times* reporter who covered the airline wars, told me a few years ago, "Your Dad took the view that the planes should be turned over to the China mainland government as the rightful owner. He found himself taking a position in favor of a Communist regime—a very righteous one, he felt—and was extensively criticized by many Americans for it."

Although Pan Am executives did not want to cooperate with Chennault, state department pressure prevailed. Juan Trippe, seeing that a business relationship with the Communists would have been impossible, at one point proposed selling Pan Am's 20 percent share of the airline to the Communist government for $3 million. Instead, on December 31, 1949, Pan Am sold its in-

COURTESY JACK FOLZ (2)

Paid by the Communist government, CNAC mechanics covered engines to protect them from Hong Kong's salty air (top) and removed the aircraft's wings, storing them in maintenance hangars.

COURTESY CLIFF DUNNAWAY, HONG KONG HISTORICAL AIRCRAFT ASSOCIATION

terest in CNAC to Chennault and his partners for $1.25 million. Thus ended what historian William Leary called "one of the great pioneering ventures in the history of commercial aviation."

Three months later, Dad came home to California. The 71 CATC and CNAC airplanes, impounded by Hong Kong's government, remained at Kai Tak airfield for nearly three years while Chennault and his partners fought Hong Kong lawyers for the right to remove the aircraft from Crown Colony territory. Three times judges ruled that because the airplanes had been used for public purposes in China, they belonged to the people of China, despite the change in their government. Expecting victory, Chinese workers of both airlines, loyal to Mao, guarded and cared for the aircraft, dismantling and preserving them. To establish ownership, they painted the Communist flag on the tails. Crew members and technicians removed thousands of tons of spare parts from CNAC's maintenance facilities and shipped them to mainland China. From those parts and with the 11 airplanes flown in on November 9, 1949, Red China established the Civil Aviation Administration of China, which became its current international airline, Air China.

Backed by strong U.S. diplomacy, Chennault and his partners finally persuaded the British Privy Council of London to hear their case. Britain's highest court ruled that since the airplanes were not located in territory controlled by the Communists, they could legally be sold to a private party. On September 28, 1952, five Convairs and 18 C-46s were transported by a U.S. Navy aircraft carrier to Los Angeles. The remaining 48 aircraft were shipped by merchant marine to California.

After returning to the states, Dad and James McDivitt went into business together acquiring aircraft and selling them to the Indonesian government. The business lasted a couple of years, but Dad didn't like the politics involved and in 1953, he retired in his late 50s to an alfalfa ranch in the Mojave Desert. At the age of 75, Dad took up glider flying. He used to say, "This is just like the old days flying in the Jenny when the engine quit."

Dad never discussed his efforts to save CNAC for the Chinese people. Anti-Communist and anti-Chinese feeling in the United States remained fierce through the 1970s, and to the end of his life in 1976, he would not put himself in the position of trying to explain.

CNAC aircraft stayed at Hong Kong's Kai Tak airport (above) from 1949 until 1952, when General Claire Chennault and his partners brought them to the United States. Ernest Allison retired to a California ranch and took up glider flying at age 75.

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BIRTH OF A STATION

The planet's most ambitious construction project gets under way at last.

Illustrations by Harry Whitver

One summer day in 2004, the international space station—a sprawling compound 220 miles up where seven astronauts will live and work for months on end—should at last be complete. As wide as a football field, the station will weigh a million pounds, have at least eight "rooms" for habitation, lab research, and storage, and produce 45 kilowatts of power from solar arrays that will themselves be among the largest structures ever placed in orbit. That's the plan, anyway.

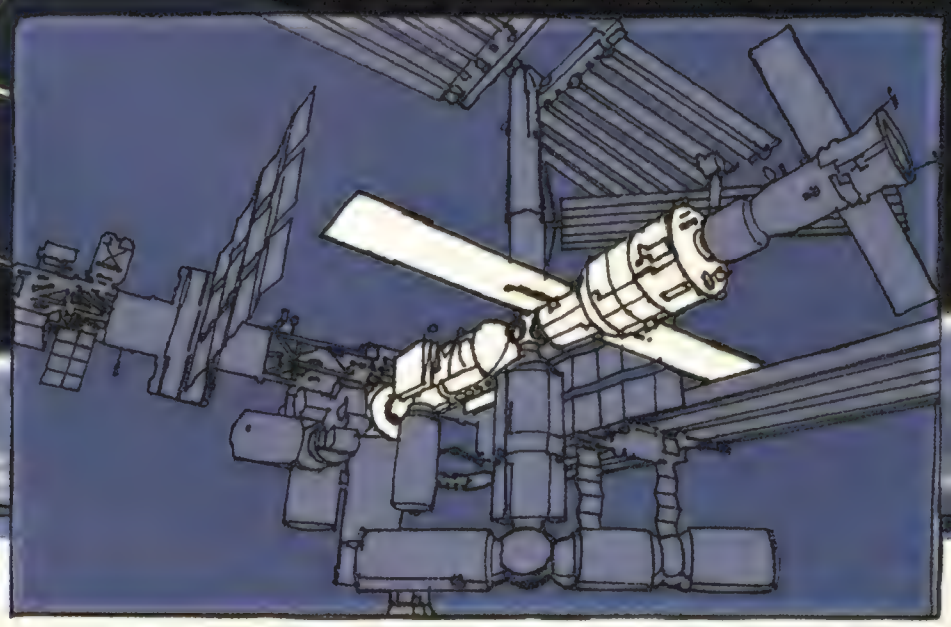
The plan has always been clear and simple, if "simple" is a word that can apply to a $50 billion project. First, a Russian-built, U.S-financed spacecraft called

Zarya—meaning "sunrise"—is launched from the Baikonur Cosmodrome on a Proton rocket (1). Also known by its Russian acronym, FGB, this is the station's utility shed, with power, communications, and maneuvering capability. About two weeks later, the first of at least 33 space shuttle missions delivers the next major piece, the Unity docking node built by NASA (2). *Endeavour* grapples the locomotive-size Russian module with its manipulator arm, aligns Zarya's docking system with the node's, and uses the shuttle's thrusters to shove the two units together. The newly joined vehicle then awaits arrival of the embryonic station's heart, mind, and muscle—the Service Module, to be built by Russian engineers and paid for by the Russian government (3). This 43-foot cylinder, based on the Mir station's core module, provides life support and living quarters for a skeleton crew of three, as well as rockets and fuel needed to keep the growing structure stable and in proper orbit.

Scheduling the space station's debut, however, has not been as easy as one-two-three. NASA has spent a lot of time, money, and political capital trying to work around problems caused by the Russian government's inability to pay for its part in the project (see "Understudy," next page). Not to mention software bugs and other last-minute headaches that threatened to derail the long-awaited "First Element Launch."

Off to a shaky start, the space station will be unlike any venture in NASA's history. Apollo had its one small step for man, the space shuttle, its nail-biting first launch. But the station, which is likely to top both in cost and complexity, will be more of a process than an event. As assembly begins, no one can predict how that process will unfold, or which players will still be in the game at the end.

—The Editors



SPACE STATION

UNDERSTUDY

In throwing in with Russia on the international space station, NASA had always understood there would be hard times. There would be two large, entrenched bureaucracies to navigate and a political gulf to bridge (not to mention two languages with different alphabets). The Russians have a unique approach to spaceflight and a very different technical culture from that of the United States. "They don't use computers in their workplace as we do," says Michael Hawes, a deputy director of NASA's Office of Space Flight in Washington, D.C. "Work plans are still pen and pencil. Mechanisms are clever and very complicated."

Even more inscrutable and disturbing to Americans has been Russia's financial situation. As of September, the Russian government had delivered only $20 million of the $320 million it promised the Russian Space Agency this year so that RSC Energia, the contractor outfitting the Service Module, could finish this most important piece of the early station (see "Plan A," p. 57). Yet some 95 percent of the hardware got completed anyway. "The amazing thing is that they've done so much without any money," marveled NASA Administrator Dan Goldin at a recent meeting of the agency's outside advisory panel. "I don't know how they do it."

NASA and its partner are like star students, one good about doing its homework, the other relying on bursts of brilliance and improvisation. "No question this is a better space station with Russia in it," says Hawes. "Bigger, more power, capacity for more people." When it comes to building space stations, he adds, "they really are the world experts on long-term spaceflight."

Paid in full by the United States, the Russians finished the station's first piece, a propulsion/storage module named Zarya that has the critical job of holding the station in the proper attitude and orbit until the Service Module arrives. NASA managers are quick to point out that the Zarya module came in on time and on budget and tested out flawlessly. But it can only do so much.

"From the beginning, we've known Zarya would be an issue because it has a limited lifetime," explains Hawes. "Its avionics are only good for a year and a half." NASA therefore always planned for the Service Module to arrive in orbit within five months of the first element launch, which seemed a comfortable margin of safety.

But without rubles from the Russian Space Agency to buy key parts, the Energia factory's work on the Service Module inevitably slowed, and the once comfortable gap between the Zarya launch and the Service Module's arrival threatened to widen to a chasm. Like a mountain climber roped to a dawdling part-

by Carl Posey

Photographs by Mark Finkenstaedt

A once-secret space tug may play a starring role in the international space station.

ner, NASA had to keep postponing its plans. The start of station construction was pushed back from November 1997 to the following June, then to November of this year. But there was a limit to how long the United States was willing to wait.

By mid-1996, some at NASA raised the ugly possibility that the Russian hardware might arrive even later, and suggested that it was time to start exploring alternatives. The search for a solution steered them toward another technical culture as different, in its way, as Russia's. They turned to the U.S. Naval Research Laboratory.

Ed Senasack (left) and Al Jacoby (center) head a team of 70 Naval Research Laboratory employees and 150 contractors building the Interim Control Module for NASA. Lee Graham (right) is the agency's onsite rep. NRL engineers have done much of the work themselves, from assembly (opposite) to wiring (top).

Though NRL is not the first acronym that springs to mind in connection with space engineering, the Navy laboratory got into the satellite business before NASA was formed in October 1958. By then NRL engineers had already built and launched Vanguard 1 following a couple of earlier rocket failures. Space work has continued there at a modest but steady pace ever since. The lab's Naval Center for Space Technology built the low-budget Clementine spacecraft, sent to the moon in 1994 as a test of hardware and techniques for the Strategic Defense Initiative. Clementine returned almost two million lunar images and took measurements suggesting the existence of water at one pole—all for $80 million. To some, this miracle of thrift and miniaturized technology epitomized the "faster, better, cheaper" philosophy espoused over at Dan Goldin's NASA.

But neither Clementine nor the other heroics in NRL's 75-year history—including pioneering work in the fields of radar and satellite navigation, and the award of the 1985 Nobel Prize in chemistry to a lab scientist—was the real draw when NASA went looking for a solution to its Russian problem. Instead, the civilian agency was attracted by NRL's experience in launching more than 80 spacecraft, some of them into the blacker-than-black void of satellite reconnaissance. In particular, NASA wanted to know more about a vehicle called the Titan Launch Dispenser, a powerful 12.5-ton upper stage designed to deliver a small clutch of ocean-viewing satellites into various orbits from which they could spy on the Red Navy.

Exactly how this device came to the attention of space station managers is unclear. No one had suggested it back in the early 1990s, when NASA engineers were considering options for a control vehicle to maintain the orbit of what was then called space station Freedom. Nor did the idea surface in 1993, when Russian modules were proposed for the station propulsion job.

By the time the Service Module schedule began slipping in 1996, however, "some NASA folks with a background in both worlds [classified and unclassified] talked to NRL," remembers Hawes. "They thought they could adapt [the Titan Launch Dispenser]. Around Thanksgiving 1996 we had our first interchange meeting with folks at NRL. We came to a quick conclusion it was feasible. While it had not shown up in the search a few years earlier..." Hawes shrugs: Now here it was.

The story of how the Titan Launch Dispenser was suddenly revealed to NASA comes in different versions, most of which tend to get blurry as the teller remembers the constraints of secrecy. Some recall that a couple of NRL guys who happened to be at a NASA propulsion conference came forward and said, in effect, "Hey, we have this stage."

The National Reconnaissance Office, which has been using the NRL upper stage for spy satellites since the 1980s, remains mute on the subject. Still, national security officials must have concluded by 1996 that the Titan Launch Dispenser was no longer such a secret that it couldn't be shared with NASA. So after having spent its career helping capitalists spy on communists, the NRL's invention would now be used to fix a

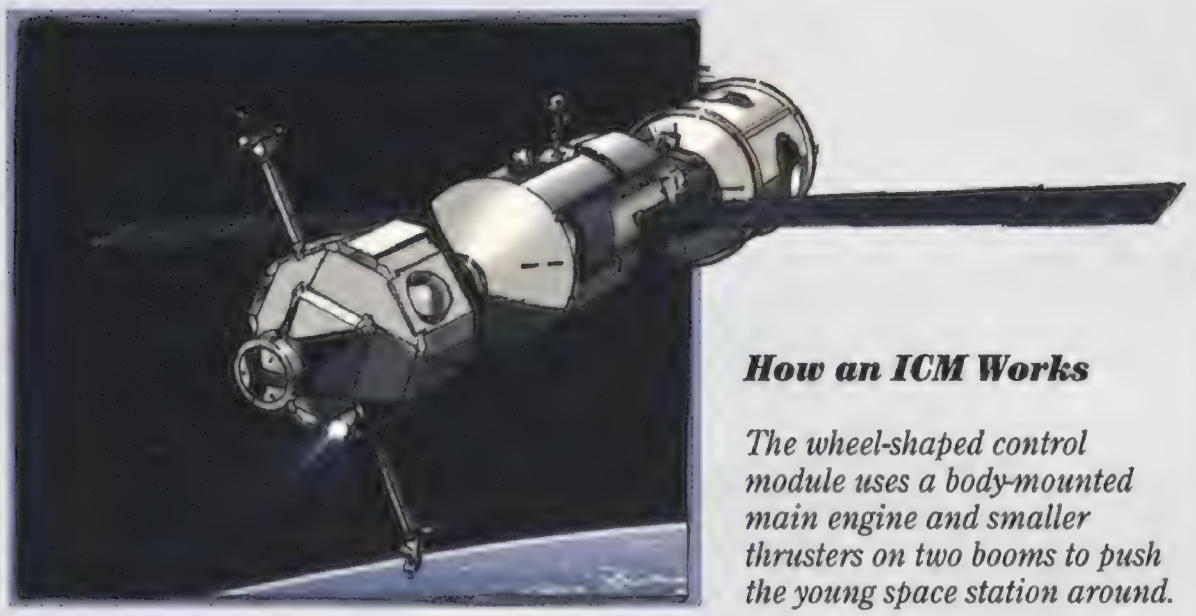


ILLUSTRATION BY HARRY WHITVER

How an ICM Works

The wheel-shaped control module uses a body-mounted main engine and smaller thrusters on two booms to push the young space station around.

problem arising from Russia's shaky transition to a free-market economy.

The Dispenser—which NASA renamed the Interim Control Module, or ICM—had an immediate and important advantage: It could fit in the space shuttle's cargo bay. Even though it had been rejiggered to fly on the Titan launcher after the *Challenger* accident, it originally was designed to ride in a NASA orbiter. In fact, the old shuttle-qualification model was still at NRL. The once-secret upper stage was also a bargain—it cost NASA only $120 million, most of it accounted for as "government-to-government activity," a kind of interagency barter. If the Russians weren't timely with the Service Module, NASA had a viable stand-in.

Like most understudies, though, the ICM was not as well suited for its role as the absent star. It was hired to do only one thing: keep the early space station stable in orbit. It offered no habitat and no life support capability, so if the Russian Service Module never arrived, NASA would have to scrounge other sleeping arrangements for the early space station crew. (Among the possibilities were having them camp in one of the small docking nodes or temporarily replacing some of the U.S. laboratory module's science equipment racks with bunks.)

NASA, of course, hoped never to have to resort to Plan B. NRL engineers thus began work in January 1997 to deliver the ICM by September 1998, fully understanding that if all went well and the Service Module made it to the show on time, their hard work might be for naught. Given the unique technical culture of the place, it didn't seem to matter. In the lab's long history, as in the history of art, much has been done for its own sake.

Located in southwest Washington, D.C., across the Potomac from Alexandria, Virginia—employees once commuted by Navy launch—the laboratory occupies a campus of low buildings interspersed with hangar-like structures, something like a movie lot. Its traditions were shaped by the Navy's historic preference for doing things itself and in its own way. NRL calls itself "the Navy's corporate laboratory," and one suspects its institutional DNA is not very different from, say, that of Lucent, where the original mission of telephony produced a wealth of technological innovation. It's the kind of place, says one NRL engineer, where you're told: "Here's some money, go do the great thing."

"Many of the companies around today got their start in labs," says Ed Senasack, a cheerful, mustached man who heads the Spacecraft Engineering Department of the Naval Center for Space Technology. "I run exactly like a business," he says, except that government rules make his business more difficult than most. "I can't take a fixed-price job because I'm not allowed to make a profit, and I can't take a loss. By law, I pay my rent. We're driven by success—if you don't perform, you don't get work. Nobody's promised us the next job."

For the last two years, the job at hand has been building the ICM for NASA, which became Senasack's prime client. NASA's timing couldn't have been better, according to ICM project engineer Allyn Jacoby. NRL employees are well aware that when work dries up, the lab downsizes, just like in the civilian world.

Last summer, the work they were doing was dispersed on large metal jigs in a vast, vanilla-walled hangar of a building. Understudies are supposed to be somehow less than the original, but the spacecraft taking shape there was hefty, about 15 feet in diameter and 17 feet long, its octagonal flanks festooned with solar panels, like a jeweled girdle holding six metal spheres—fuel and pressurant tanks.

In fact, the ICM is really a kind of flying fuel system. Around an oblong space at its center, four spherical tanks are arrayed—two for the nitrogen tetroxide oxidizer and two for the monomethyl hydrazine fuel. The blend is hypergolic, meaning that the chemicals ignite spontaneously when mixed in the rocket engine's combustion chamber. Two smaller spheres in the frame con-

An NRL engineer checks the positioning of small reaction control nozzles on one of the ICM's two telescoping arms.

tain helium, which provides an inert-gas pressure in the other tanks of 3,000 pounds per square inch. All together, the ICM can supply 11,500 pounds of propellant, enough to hold the early space station for a year, a year and a half tops. In the absence of the Russian Service Module, it would plug into a docking port at the wide end of the Zarya module.

"When NASA first came to us," Senasack says, "they said, 'We'll take what you have. No changes.' We liked that." He grins. "There was a significant amount of residual hardware from the Dispenser program. Mainly spares, canisters, structures, tanks. Without the residual hardware, we couldn't have done it. We were able to leverage off three years of work in the 1980s."

But once the NRL and NASA engineers started talking in more detail about the requirements, it became clear that the Titan Launch Dispenser wasn't a perfect fit right off the shelf. For one thing, it was spin-stabilized, meaning that it had to keep turning slowly about one axis to stay balanced. NASA's ICM would need three-axis stabilization to hold its position in space. For another, the rocket engine used for spy satellites produced 900 pounds of thrust, much more than what NASA needed for the space station job.

So Senasack's team started tinkering with the basic design. The ICM's small reaction motors, which stood off from the main body of the spacecraft on two extendable metal arms, had to be repositioned for three-axis stabilization. A 110-pound-thrust engine replaced the heavier original, and new avionics were stuffed into the vehicle. Because fuel behaves differently in a spinning spacecraft, where centrifugal forces slosh it outboard, a new fuel distribution scheme had to be designed to feed the main engine and the smaller vernier thrusters.

Now that the craft would no longer be spinning—and therefore would have one side exposed to the sun for long periods—its thermal characteristics would be very different from its predecessor's. Finally, this orbital tug would have to do something it never had to do when toting around spy satellites: adjust for the space station's changing mass and geometry over time. NASA asked NRL for a vehicle that could help keep the station aloft from assembly flight 2A—when just the Zarya and Unity are up—through at least flight 7A, when giant solar arrays, girder-like trusses, the U.S. laboratory module, an airlock, and other equipment will be attached. As the station grows, its center of gravity will shift and it will produce more drag in the thin atmosphere 220 miles up. The ICM control software that dictates which thrusters fire and for how long will have to accommodate these changing circumstances.

To make NASA's deadline, all these modifications had to be done without tearing the whole thing apart and starting from scratch.

"It was like building a ship in a bottle," Senasack says of the transmutation from Titan Launch Dispenser to ICM. "To pull this off in time, everything had to go through a hole in the side. All that stuff through a five-inch-wide hole. We couldn't redo the tanks. To get any fuel tank in this country takes 18 months if you walk in there with a design. Fifty-two-inch-diameter tanks are not on the shelf anywhere."

To keep things simple, the engineers went out and bought the same kind of vernier engines used on the space shut-

Plan A

The Service Module, which now sits unfinished on a factory floor in Korolev, Russia, may end up among the most notorious spacecraft of all time: Its delays already have brought the largest international space project in history to the brink of political disaster. And even if it flies next year, the delicate U.S.-Russian space partnership formed in 1993 may not survive in its wake.

What happened? Five years later, all NASA could say is: The Service Module seemed like the best bet at the time.

Its design, after all, is modeled closely after the "core block" of the existing Mir station, and required no major innovations. The propulsion system and avionics have been upgraded, there's more redundancy, and systems for thermal control and navigation have been much improved.

But any cosmonaut who has lived in space in the past decade would feel immediately at home in the new module. It has the same kind of galley and bathroom, same observation windows, and same bulbous docking ports (two instead of Mir's four) for visiting spacecraft. If things had gone differently and the Russian economy had not gone bust, the Service Module might have become the nucleus of an all-Russian Mir 2 complex rather than the cornerstone of the U.S.-led international space station.

The module's shell was built by the Khrunichev Production Center in Moscow, and the inside systems work was done at the RSC Energia plant in nearby Korolev. Both are experienced spacecraft builders. The weak player on the team was the Russian government, which never came through with funds promised to the Russian Space Agency. What finally held up the module's completion was the unwillingness of outside vendors to deliver key subsystems to Energia, including the television and satellite navigation systems, without being paid.

So versatile is the Service Module—it is itself a fully functioning mini-space station—that NASA built the early station assembly sequence around it. Despite the agency's occasional assurances to Congress that no non-U.S. hardware would hold up station assembly for want of a backup, the Russian Module ended up squarely in the "critical path."

NASA

It may still reach orbit. It is, in many ways, the best option for NASA, which is paying to see it finished. But the rest of "Plan A"—full partnership with the Russians on a jointly operated station—was already unraveling as the station's first pieces moved to the launch pad.

—Tony Reichhardt

tle to mount on the ICM's arms. Another problem solved. "There were a thousand technical snakes," recalls Senasack. "The thermal design. We're designed to be a spinner. Can we come up with a thermal design?" He offers a feline smile. "We used the system from Clementine."

As he speaks, a casually dressed man walks by carrying a nest of electrical cables. Others wander the polished concrete floor with ICM plumbing, plans, breadboard electronics. Senasack points out that these are engineers, not technicians. At NRL, he says, everybody does everything. "It's kind of a different environment," he says. Two of the engineers working on the thruster redesign came out of retirement, drawn by the challenge of getting a difficult job done in a very short time. They were even willing to work for the difference between their pensions and their former salaries.

NRL's corporate style extends even to the bureaucratic game of procurement. "Many of the new technologies you'd want to put in space weren't designed for space," Senasack says. "We believe in being a smart buyer; otherwise you end up with technology that's seven years old. You lay all this on a contractor, the guy wonders whether he really wants to play. We go in and develop hardware and help them. 'Don't use this aluminum, use this kind.' Procedures. Wiring. If they say 'We can't do that,' we say 'Okay, bring it out and we'll do it for you.' A contract is a contract to work as a team to get this done."

Senasack is more than just a True Believer—he has a deep taproot into the lab and its traditions. His father worked at NRL for 35 years, and he's been there for 27. People tend to stay. Allyn Jacoby just got his 25-year pin. About the only real newcomer here is NASA's Lee Graham, deputy manager of the ICM project (the manager is at the Johnson Space Center in Houston). An 11-year NASA veteran, Graham arrived at NRL in September 1997, one of three people sent by the space agency to help Senasack's 70-odd lab personnel and 150 or so contractors working on the ICM. Among other things, Graham's presence on site ensures that NASA is a full partner in the project rather than "just sitting there monitoring a contract," as Senasack puts it.

But here, as in Russia, some acculturation was necessary. "We had a little problem in the beginning with the NRL—versus the NASA—approach," Graham says. "NRL's got a pretty fast approach; ours is a little lengthier review process. They're a very hands-on organization. It's not that often that NASA folks get that close to the hardware. We generally do a presentation. So this is kind of a nice change for us as well."

Get Up and Stay Up

As luck would have it, NASA and company will be building their space station during the worst part of the 11-year sunspot cycle, when increased solar activity will heat and inflate the atmosphere, raising the density of its thin upper layers. Greater density means more drag on the station's enormous solar panels. The abandoned Skylab station came crashing to Earth prematurely during the solar maximum of 1979, a lesson NASA hasn't forgotten.

Even with a quieter sun, the space station, like any large spacecraft, needs a periodic reboost to counter the effects of drag. The plan calls for around six reboosts a year, with an overall annual increase in altitude of 20 to 60 miles, depending on the station's configuration and the solar cycle.

Now the bad news: Reboost, in fact all primary propulsion for the station, is Russia's responsibility. And Russian space officials recently admitted that they probably won't be able to afford the six Progress vehicles a year that they were supposed to attach to the Service Module to give the station its regular pick-me-up.

Fighting off panic, NASA engineers immediately came up with a $90 million stopgap solution. They will modify each of the four space shuttles (re-plumbing fuel lines to deliver more propellant to engines in the orbiter's nose) so that they can handle most of the reboost duty. But the shuttle is far from ideal for the job. It has to hoist its own mass as well as the station's, which makes it only about half as fuel-efficient as the much smaller and lighter Progress. The NRL's Interim Control Module, which is designed for attitude control, is not a good solution either.

A permanent replacement for the Russian reboost capability would be the so-called U.S. Propulsion Module, which NASA has gingerly asked the White House budget office and Congress to consider funding. Boeing already has a concept in hand. Visiting shuttles would dock with this "prop module," which would itself be docked to the U.S. Unity node (a pressurized tunnel would let the crew transfer from shuttle to station). Each time a shuttle came up, it would dump whatever extra fuel it had into the prop module, which could store 12 tons of propellant, enough for two years of reboost.

The prop module would have large (100- to 200-pound) thrusters for reboost, and smaller (25- to 50-pound) ones for day-to-day attitude control. It could answer all the space station's propulsion needs—all but one, that is. While the space shuttle is docking with it, the prop module would be prohibited from firing its jets. Some other vehicle, then, would have to maintain active control of the station during docking. For now, that other vehicle is the Russian Service Module. Even with a U.S. prop module, says Frank Buzzard, NASA's chief engineer for the station, "you always need a Russian propulsion capability.... You never get away from that."

—Tony Reichhardt

Reboosting the station is supposed to be the job of the Russian Progress vehicle (foreground, at right, docked to the Service Module), but NASA worries that it may not report for work.

ILLUSTRATION BY HARRY WHITVER

Says NASA's Lee Graham: NRL is "a very hands-on organization."

In fact, Graham muses, the NRL people are "a lot like the Russian folks in many ways. They remind me a good deal of Khrunichev [the factory in Moscow that built the Zarya module]. The Russian facility even looks a lot like NRL. Both are motivated to do things quickly and not relearn everything. They keep modifying and reusing stuff. A small, close-knit organization with technical experts in each discipline."

Graham says the Navy lab cuts through the usual maze of acquisition paperwork by going to contractors they've used before and buying off the rack. He also admires the lab's clever way with leftovers. "These guys don't throw anything away," he says. "The electronic boxes are the same racks as those used on earlier programs." They just repainted them for the ICM.

NASA has contributed its own unique expertise to the project, Graham says. When ICM engineers needed an analysis of when the craft would be in sun and when in shadow, and how that might affect onboard temperatures and output from the solar power panels, the task was farmed out to NASA's Lewis Center in Cleveland. Another NASA center helped with the extremely delicate business of bending hair-thin leads that join microscopic chip circuitry to larger circuits. One of NRL's electrical contractors remembered making a special lead-forming tool for the Jet Propulsion Laboratory in California. Graham contacted JPL, got to use the instrument, and saved weeks of work.

All the tricks have paid off: Fabrication of the basic spacecraft is complete, integration with other hardware is under way, and the project is on schedule (having used launch slips to further improve the module's avionics) to ship the ICM to the Kennedy Space Center on a C-5 Galaxy next summer.

Will it ever make it into space?

From the start, NRL engineers have configured the vehicle as a stand-in for the Service Module in case it's never launched or fails after reaching orbit. If the Russian module works properly, though, the ICM could be reconfigured to play some other role in the ongoing space station drama.

For example, NASA managers have become increasingly nervous about another possible Russian no-show: the Progress tankers that will deliver fuel to the Service Module and boost the station periodically to maintain its proper altitude. So worried is NASA, in fact, that the agency started the political machinery moving to secure funding for a permanent "U.S. Propulsion Module" that would lessen its dependency on Russian propulsion capability (see "Get Up and Stay Up," previous page).

Congress may be in the mood to grant the request. For the past two years, James Sensenbrenner, the Wisconsin Republican who chairs the House Science Committee, has fumed about Russian non-progress on the Service Module. NASA's Dan Goldin flew to Moscow to find out what was hanging things up. So did Al Gore. So did Sensenbrenner, and half a dozen others. Always they were told "The money's coming." It never arrived.

When a desperate NASA asked permission in October to transfer $60 million in emergency funds to the Russian Space Agency to finish the Service Module and get on with space station construction, Congress attached strings to the payment: NASA had to submit a plan that "eliminates United States reliance on Russia at the earliest possible date." That plan includes a permanent U.S. Propulsion Module.

But no one can guarantee that a U.S. module, which would take at least three years to build, wouldn't run into its own problems and delays. Wouldn't it be comforting to have the ICM waiting in the wings, just in case?

"[NASA] has said repeatedly it's going to build this thing and put it on the shelf—*just for insurance*," says Graham. And even if the ICM never flies on the space station, it eventually will be called to active duty somewhere.

"It's a fully capable, three-axis-stabilized vehicle with a lot of propulsion capability," says Frank Buzzard, chief engineer for the space station at NASA's Johnson Space Center in Houston. "It could be used for some other NASA mission, like sending a satellite someplace. We won't throw it away. We'll use it for something."

In fact, the ICM already has served one important function. In the tense but not unfriendly chess match between NASA and its Russian counterparts, it became a bargaining chip. Two years ago, the United States had few options for replacing Russian hardware. But when Energia's subcontractors threatened to hold up the entire $50 billion space station project by not delivering key Service Module components, the ICM provided blackmail insurance. Russian visitors to NRL saw for themselves that the Americans had a backup. And, says Hawes: "They saw it wasn't just a paper design." A bluff, maybe, but the perfect role for an old cold war veteran like the ICM.

FrigidAir

Flying over the far North, the Royal Canadian Mounties are about to find out if one engine is better than two.

by Joseph Bourque

Photographs by Erik Hildebrandt

From 7,000 feet, the Arctic terrain is a dream landscape—endless miles of snow and ice with not a tree, not a shrub, not a sign of life or habitation. The relative coziness of the Twin Otter's cockpit lends a deceptively benign appearance to the vast Baffin Island barrens, but as a pilot, I have a "what if" gauge, which registers that the ambient temperature on the ground this February day is –40 degrees Fahrenheit. With a 15-knot breeze, that's a wind chill of about –90. A crash landing here, about 120 miles from the nearest help, would turn the dreaminess into a nightmare. In these conditions, you have about 20 minutes to make decisions that will keep you alive.

Staff Sergeant Bob Sellinger of the Royal Canadian Mounted Police Air Services is pilot in command. I'm along for the ride in the copilot's seat of this impeccably maintained de Havilland DHC-6 Twin Otter, which is about to be retired. After nearly 30 years of service in the eastern Arctic, this Otter, part of the RCMP's aging fleet of 10 Twin Otters, will be replaced by the newer, sleeker, single-engine Pilatus PC-12.

De Havilland aircraft—single-engine Beavers and both single- and twin-engine Otters—have been the Air Service's reliable workhorses for Arctic patrol since 1949, and not everyone is happy about the switch. "For most pilots, upward mobility means moving from a single to a twin," says Peter Kember, recently retired officer-in-charge of Air Services, who gives me a briefing a few days later over lunch in Ottawa. To some RCMP pilots, the single-engine Pilatus seems a step backward, despite its advantages: It's 100 mph faster than the Twin Otter and has more than twice the range, both important qualities for work in the Arctic.

It would be easy to develop an attachment to an airplane that purrs as sweetly as this one. Sellinger, who has never flown the Pilatus, praises the Otter. "It's very rugged, very reliable," he says. "Flies like a truck. In fact, we use it like a truck." And its fat 19-passenger fuselage looks like a truck—one that is suspended on a long, thick, high, slow wing. Only the engine nacelles, housing Pratt & Whitney PT-6 turbines, look slim and dainty.

"Want to fly it?" asks Sellinger. He flips off the autopilot and I'm in control. I'd been thinking pickup, but it turns out to be more like a heavy-construction dirt hauler. To someone who normally flies a Cessna 172, the controls feel heavy, sluggish, and unresponsive—but sturdy. After 10 minutes I'm bored enough to suggest we go back to the autopilot.

Sellinger commands one of the Air Services' 21 detachments. He's stationed at Iqaluit (pronounced ee-KAH-loo-it) on Frobisher Bay, which has one airplane and three men—Sellinger, Sergeant Bruce Mulley, the other pilot, and Special Constable Dave Brown, the engineer who keeps the Twin Otter working—to serve 22 detachments of Royal Canadian Mounties, who police the small, largely Inuit communities scattered throughout the eastern portion of Arctic Canada. It's a vast land that will soon be removed from the administrative control of Canada's Northwest Territories to become a new territory, Nunavut, which means "our land" in the Inuit language.

Today's mission is typical. At several communities we'll pick up RCMP members going to Iqaluit (population 4,200) for promotion exams. Some will bring spouses for a much needed break in the "big city." We have several cases of Coca-Cola to deliver, a refrigerator, a few tools, some ammunition, and odds and ends. No police work today, or search-and-rescue, or medical evacuations—also typical missions for Air Services. Later, back in Iqaluit, I'll

Typical of the Inuit villages that dot the Canadian Arctic, Hall Beach has a frozen runway—the better to welcome the Royal Canadian Mounted Police, who have long since traded their horses for airplanes.

discover that we flew 1,735 statute miles in nearly 15 hours, including stops.

While you might think the job sounds monotonous, postings to the Arctic suffer no shortage of applicants, who relish the opportunity to fly no matter how barren the conditions. Because the cost of living in the Arctic is so high, though, RCMP aviators receive a subsidy for housing and utilities. Pilots who serve here describe the tour as peaceful and rewarding. The pace is more relaxed than in urban centers, and the work leads to a welcome familiarity. Though the RCMP pilots serve a huge area, their constituency—Mounties living in the Inuit communities—is small, and the pilots get many personal expressions of appreciation for what they do.

You'll often hear RCMP pilots referred to as saviors and saints. Inspector Dan Fudge, Sellinger's immediate boss and officer-in-charge of the entire region, says, "They're absolutely essential to the morale of the RCMP families living in the communities. Imagine yourself with a family in a settlement of 200 to 300 people where it's totally dark for two months or more out of the year and you can expect a blizzard just about any time. The nearest community, perhaps smaller than yours, is hundreds of miles away and there are no roads. You quickly learn to appreciate the airplane." The Mounties stationed in the Inuit villages have been doing for a century or so what some urban police forces have begun only recently—neighborhood policing. Most of the Mounties know every person in their jurisdiction by first name. Even in Iqaluit, the largest of the communities, repeat offenders and troublemakers are referred to as "Eddie so-and-so" rather than the "perp" or the "suspect."

A pilot with the RCMP, Sergeant Bruce Mulley flies support missions for the Mounties who live and work in the Inuit communities.

Since the Twin Otter visits each of the 22 RCMP detachments only six times a year on average, each arrival is eagerly anticipated. Says Fudge: "While there is parallel commercial air service to these communities, some scheduled and some charter, the RCMP airplane can provide our members with personal things [anything from a family heirloom to a lathe] that are important for morale and that we couldn't afford to ship by commercial carriers."

Such a role is not what the Royal Canadian Mounted Police originally planned for their first aircraft, which they acquired in 1937 to do true police work. Some historians point to the "Mad Trapper" episode as the event that most convinced the Mounties that they had to take to the air. In the winter of 1931-32, Albert Johnson, referred to ever since as the Mad Trapper, shot and wounded a Mountie who had knocked on his door to question him about stealing from native trap lines. For the next 48 days, Johnson defied a combined force of RCMP, Native Americans, trappers, and the military in a running battle through numbing cold and blizzard conditions. He wounded a second pursuer and killed a third before he was finally surrounded and killed. During the chase, the RCMP contracted with Wilfrid "Wop" May, a military and bush pilot, to deliver supplies to the various ground parties engaged in the chase and to scout for Johnson's tracks from the air in his Bellanca CH-300 Pacemaker. More important, he delivered the second wounded Mountie to Aklavik for medical attention that saved his life.

Though medical evacuations and search-and-rescue are now done mainly by private contractors and the military, Sellinger and Mulley are called out on rescue missions a dozen or so times a year, when their airplane is closer or additional help is

Snow covers the ground some nine months out of the year in villages such as Pond Inlet (left) and (below), where the snowmobile is the preferred way to get to church.

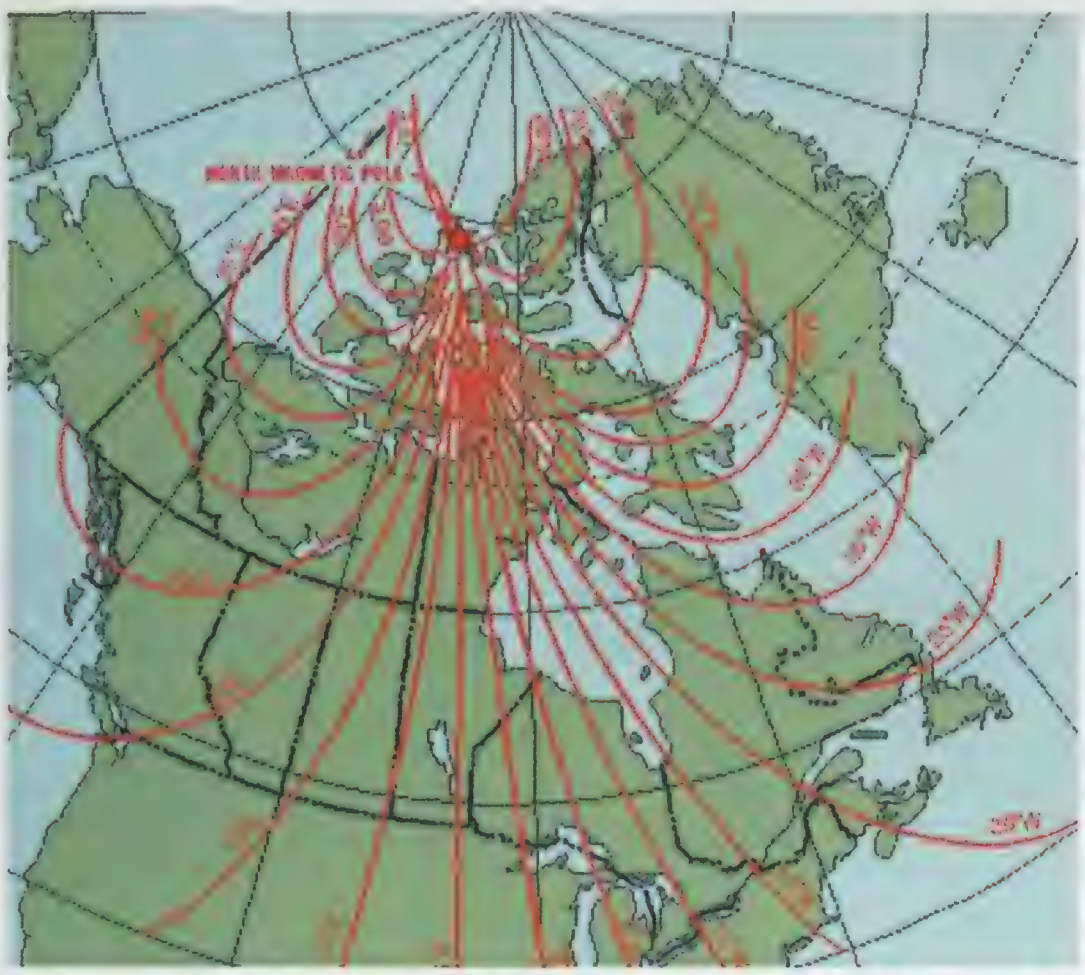
needed. At the end of March, an Inuit man who had embarked on a two-day snowmobile trip from Repulse Bay to Pelly Bay got lost. He had been missing for four days in blizzard conditions before Sellinger was called in to do a standard grid search. The pilot looked for several hours, refueled, and searched until dark without success. Later, the man said he heard the airplane pass overhead but was too weak to stand and wave. He also said it was the sound of Sellinger's airplane that made him get up a couple of hours later and walk until he was spotted by rescuers on snowmobiles.

Staff Sergeant Bob Sellinger (left) and Sergeant Robert Boyd cover a Pratt & Whitney PT-6 turboprop with a tent to contain the warmth generated by the engine heater.

At other times, the Otter has been more directly responsible for saving a life. Kember remembers one crash on the Penny Ice Cap of the Cumberland Peninsula. On a Saturday in November 1970, a Mayday came in from a Piper Aztec that was going down. It was late in the day and the weather was deteriorating, but the radio operator at Iqaluit called Kember, whose Otter was the only aircraft in the area on skis. By the time he got to the general area of the crash, the mountains were swathed in clouds and visibility was near zero. Recalls Kember: "Suddenly this shaft of sunlight came out of the clouds, like in a Charlton Heston movie, and there in the middle of it was this airplane with little figures running around." To outline a fairly flat spot in the snow, the Aztec pilot had kept his passengers busy stomping two parallel lines. Kember says he couldn't have landed otherwise because the light was too dim to see obstructions from the air. "They didn't have much survival equipment aboard that plane," he says. "As we left, the weather closed in completely and stayed that way for three days. But for that shaft of sunlight they would have died of exposure during the night."

For now, I've temporarily forgotten the intense cold as we cruise at 160 mph. The slanting sun paints a few shadows on the mildly undulating landscape below and splashes a golden glow on the tops of the mountains along the eastern coast of Baffin Island. This first leg is one of the shortest, only 300 statute miles between Iqaluit and Broughton Island. While we take in the barren beauty of the scenery, we do what all sensible, red-blooded human beings should do whenever they can. We talk about airplanes.

The Twin Otter we're flying, for example, has been in service in Iqaluit since 1971, and its twin Pratt & Whitney turboprop engines were a significant step toward more comfortable and efficient performance in Arctic cold. Its immediate predecessor, the single-engine Otter, was much noisier and a lot more finicky. "Piston engines operate poorly in extreme cold," says Sellinger.

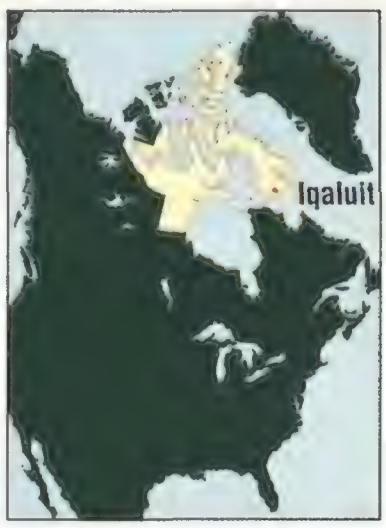


LARRY NEWITT/GEOLOGICAL SURVEY OF CANADA/NATURAL RESOURCES CANADA

Navigating the North

Compass-based navigation is trickier in the far north than it is in southern Canada and the lower 48. The difficulty arises because maps, including aeronautical charts, use the North Pole (the north end of Earth's axis of rotation) as a navigational reference point, while compasses line up with the magnetic north pole (the north end of the axis of Earth's geomagnetic field). The discrepancy between true north and magnetic north varies across the globe (as represented by the curved red lines). It is possible to fly a route in which true north and magnetic north are aligned, and in those cases no navigational correction would be needed. But if you originate a flight from, say, the east border of Washington State (where magnetic north measures 15 degrees to the east of true north) and fly west to Seattle, you'll need to periodically adjust your directional gyro to allow for the fact that at your destination, magnetic north measures 20 degrees to the east of true north. Pilots flying compass-based navigation systems in the Arctic must be extra vigilant; because of their proximity to magnetic north, magnetic variation can change frequently—within the space of only a few miles.

Although pilots never had to drain their oil and sleep with their batteries as other non-Mountie piston-engine pilots did, engineers developed a rigmarole for operating the singles, according to Glenn Brown, Dave Brown's father, who was the engineer at Iqaluit between 1962 and 1965, more than 30 years before his son took the job. Brown remembers using the Otter's oil dilution equipment in the days when most of the communities had no power and no airstrips. "When you shut down for the day, you'd hit the switch and a solenoid on the carburetor would pump about three quarts of gas into the oil," Brown says. "The next morning we'd put up an engine tent with blow pots—the kind plumbers use to melt lead—until the engine warmed up enough to start. Then you had to run the engine for a while to burn off all the gas you'd pumped into the oil."



In April 1999, the highlighted portion will become a new territory, Nunavut (capital Iqaluit).

Sellinger dips a wing to give me a better look at the tiny community of Pangnirtung Pass. "The wind blows so hard in Pangnirtung," says Sellinger, "that they tie down the houses by running cables over the roofs and anchoring them to the bedrock."

A while later, we're setting up for a landing at Broughton Island. "Can you see the runway?" asks Sellinger. I cannot. "Can you see the community?" he asks. I see a thin smudge that could just as well be shadow. "Look to the right of that smudge about a half-mile," he says. As the smudge becomes more clearly a village, I finally see the misty outline of a rectangle barely distinguishable from the snow around it: the runway.

"All of the runways we'll land on today are gravel, with the exception of Iqaluit," says Sellinger. Since the runways are regularly swept by windblown snow, they tend to disappear into the landscape. "But they're frozen solid as concrete in the winter. Even better than concrete because there's more traction," Sellinger says. The Twin Otter's stall speed in landing configuration is 65 mph, so we linger on final approach, giving me time to look around. Beyond the small scattering of buildings, three large icebergs protrude from the ice in the small bay. Since they drift through the icy waters, they aren't on navigation charts and can pose a collision threat to air traffic. Staff Sergeant Bob Bemrose, who flew Twin Otters here in the 1970s, tells of making an instrument approach into Clyde River one night through clouded skies. "The approach required descending to about 300 feet," he says. "When we got up the next morning, there was an iceberg rising about 250 feet out of the water just off the final approach to the runway." Occasionally, the tops of icebergs rise up into the clouds.

We taxi up to a couple of buildings and Sellinger maneuvers the Otter, which has a five-and-a-half-hour fuel capacity, as close as possible to the gas pumps. He refuels at every stop, no matter what. "Many of the legs between communities are three hours or more in adverse conditions," he explains. "If the weather drops below minimums when you get there, or one of the frequent ground blizzards whips up, the nearest emergency alternate could be two hours away or more. There's very little margin. Taking off with a full load of fuel and cargo may put you over gross weight, and that

may not be best from a fuel economy point of view, but this airplane handles it well and that extra fuel could save your life later."

Fuel is a critical issue in other ways. "The Twin Otter will burn anything, even av-gas with some limitations," says Sellinger. "Nowadays we can count on finding regular Jet A or Jet B most of the time, but we carry a full set of filters in case we have to use an unreliable source." The older hands remember tougher times. Staff Sergeant Barry Perlin, an RCMP pilot who flew a Twin Otter out of Yellowknife in the mid-1980s, says: "We often had to gas up from barrels. Besides the extra work of fighting the barrels, we had to worry about what was in them. We often had to interrupt fueling because the filter was clogged with ice crystals. Occasionally we had to burn furnace fuel. Most times the truck [driver] had just finished filling a tank at somebody's house and rewound the hose with the nozzle dragging in the dirt or the snow, depending on the season. If he sensed you watching over his shoulder, he'd pull out a rag and sort of give the nozzle a swipe."

We leave Broughton Island, after unloading the Coca-Cola and some

One drawback of the de Havilland DHC-6 Twin Otter (above and below) is that the cabin is unpressurized. At altitudes exceeding 10,000 feet, occupants must don oxygen masks.

ammunition. For the next half-hour, Sellinger keeps us about 800 feet off the ice. He wants me to see the variety of iceberg shapes, some extravagantly beautiful. We're also looking for polar bears. This is an area where they might have a fishing hole in the ice. We now have two passengers in the rear cabin, Corporal Mark Wharton and his wife Linda. In about 15 minutes, Mark shouts: "Polar bear off to the right. He's running like hell." Sellinger cranks us into a right-hand turn and we

MIKE REYNO PHOTO (3)

retrace our path for a few miles, but we never see the bear again.

As we get back on track for Clyde River, I realize that we crossed the Arctic Circle at a latitude of 66 degrees. We're now at 68 degrees and plowing steadily northward, where the deviation between the geographic North Pole and magnetic north is magnified (see diagram, p. TK). "Where we are now, the magnetic variation from true north is about 55 degrees," says Sellinger. "At Grise Fiord, the variation is 80 degrees." So you'd better know whether you're on a magnetic or a true heading.

In the days before the RCMP acquired the Twin Otters, navigation was somewhat primitive. "The single Otter had only a 'coffee grinder' [hand-cranked] automatic direction finder, but then none of the communities had beacons," remembers Glenn Brown. "For parts of some trips, the pilot could find a Distant Early Warning Line [military navigational radio] beacon, but flights to the remotest locations were done by compass alone." Still, the singles managed to get the job done. In February of 1955, an RCMP single Otter based in Churchill, Manitoba, rescued two of the three crew members who had parachuted from a U.S. Air Force B-47 Stratojet that exploded over northern Saskatchewan.

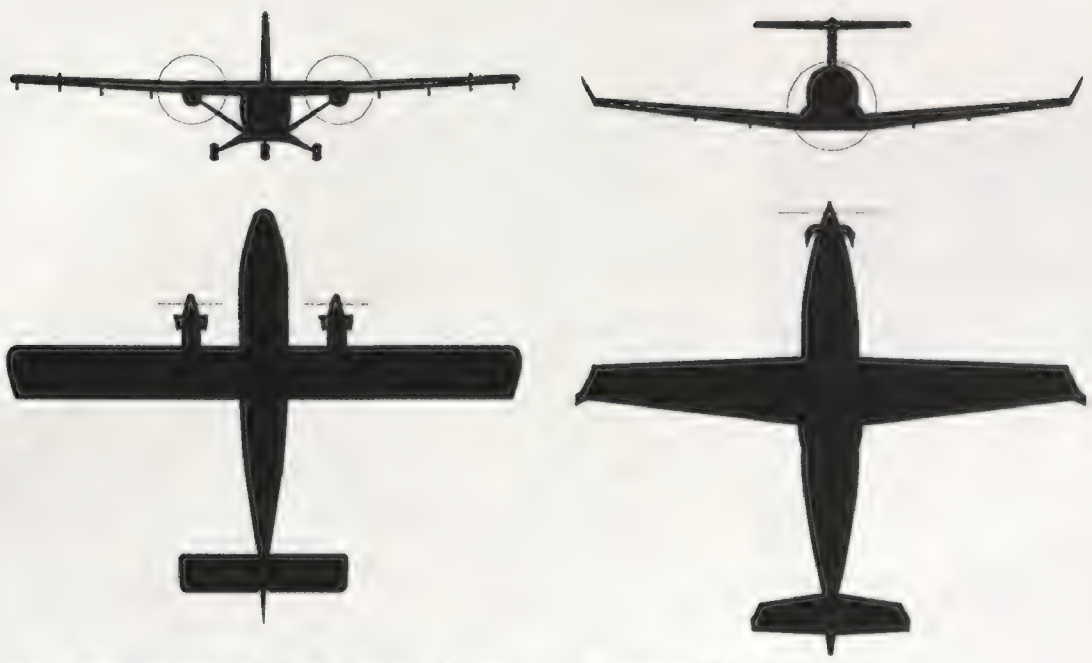
Installed in the Twin Otters in 1985, the Omega navigation system, based on a very-low-frequency network of stations around the world, took some of the guesswork out of getting from point A to point B. For the first time, pilots had a consistent reference to guide them along the entire route. Omega's major drawback was that it was easy to make a mistake when punching in the latitude and longitude numbers for the destination. A one-digit mistake could result in a gross navigational error.

Finally, in May of 1997, the RCMP equipped its fleet with KLN 900 GPS units with moving map displays. They're equipped with software that can switch all calculations from a true north to a magnetic north reference point and vice versa. Says Sellinger: "GPS is the best thing since wings."

But that still leaves the cold. Though the Twin Otter's engines are supposed to start at a temperature of –40 degrees Fahrenheit, most pilots say that in winter, they wouldn't leave their airplanes parked for more than an hour without plugging in heaters to warm the engines. As for the cabin and cockpit, after sitting 45 minutes on the ground at Broughton Island, the inside temperature was about the same as outside, –38, and it didn't warm up until we were airborne. "If you get into the cockpit and the seat cushion feels like a table," says Perlin, "you know it's about minus forty. And you'd better be sure you have your gloves on before you hit the starter or you might not be able to let go of it."

Even worse is what the cold can do to the flight controls. "You have to be very careful about jerking the control yoke around at first," says Perlin. "If the wires connected to

After more than 60 years of relying on de Havilland aircraft, the RCMP have decided it's time to move on; their seal (above) now graces the newer, sleeker, faster—and pressurized—Pilatus PC-12 (top and bottom).



de Havilland DHC-6 Twin Otter

First flight: May 20, 1965
Wingspan: 65 ft.
Length: 51 ft., 9 in.
Max. takeoff weight: 12,500 lbs.
Cruise speed: 210 mph

Pilatus PC-12

First flight: May 31, 1991
Wingspan: 52 ft., 9 in.
Length: 47 ft., 2 in.
Max. takeoff weight: 8,818 lbs.
Cruise speed: 310 mph

Drawings not to scale

it are cold enough they can snap, or your autopilot might not work for a while. Cold-soaked tires are fragile, and a tight turn while taxiing is likely to blow a tire."

As Sellinger sets up to land at Clyde River, I'm realizing that most of these communities are similarly arranged: a small cluster of houses engulfed by a vast landscape, and a runway with a couple of buildings. Occasionally I spot a gas truck, its tanker portion mummified in a case of ice and snow. Clyde River has a population of 708, Nanisivik, 287, and Grise Fiord, only 148. In most, the population is more than 90 percent Inuit, and the few non-natives are government workers.

At Nanisivik we're delivering the refrigerator, which hardly seems necessary. When we contact the radio operator, the first question is "Are you bringing our refrigerator?" Sellinger says yes. "Great!" says the voice at the other end. Sellinger, Mulley, and Brown often claim that for them, "RCMP" means Royal Canadian Movers and Packers. Their busiest season is in the summer, when they move the belongings of RCMP members reassigned to other stations in the Canadian Arctic.

Though they seldom use it as a mode of transportation, the Inuit still train for and compete in dogsled competitions. Dogs can tolerate the very low temperatures of the Arctic, but airplanes often have problems. Flight control cables, tires, and engines all need some degree of coddling.

The final leg of today's trip runs southeast from Hall Beach on the Melville Peninsula to Iqaluit. The moon is up and I can see boundless stretches of ice. I know that we have 250 miles of it to cross before our next landfall, back on Baffin Island. What worries me is that strong currents move through the Foxe Basin below, keeping the ice from forming a solid mass. It sure doesn't look as though the ice would support the weight of our airplane. I don't ask. The Otter carries a survival kit, of course—sleeping bags, extra clothing, tent, food, shotgun. But the kit presumes the opportunity to use it.

I ask Sellinger how he would feel about flying this stretch in a single-engine Pilatus PC-12. "This Twin Otter flies really well on one engine," he replies. "But I think I'm willing to trade for the speed and range of the Pilatus—especially the speed. We could get so much more done in so much less time." And the Pilatus, with its pressurized cabin, offers a more comfortable ride than the unpressurized Twin Otter, in which occupants must don oxygen masks at altitudes exceeding 10,000 feet. Says Sellinger: "There's a lot to be said for a pressurized cabin that will take you up above the weather. After you've been here a while, you get tired of bouncing around down here in bad IFR [instrument flight rules] conditions."

The Twin Otter does have its charms, though. This morning, with the temperature at –40 and a 17-mph headwind, we almost

helicoptered off the runway, proof of the Twin's short-field capability. Superintendent Dave Sperry, the current officer-in-charge of Air Services, tells of a flight he made in the Yukon, taking medical personnel to a heart attack victim. He landed on a very short sandbar at the bend of a river. They waded across and, since the man had died in the meantime, loaded the body aboard the Twin Otter. A helicopter pilot who had arrived on scene said: "Do you mind if I hover off to the side here and watch? I don't think you can get that airplane out of here." Sperry replied: "Well, they won't let me leave it here," and climbed aboard. He finessed the Twin out, just clearing the trees.

A few days later, Sperry and Kember explain the economics behind the decision to retire the airplane. For one thing, a Twin Otter's entire wing box must be replaced at 33,000 hours, except for the flaps, ailerons, and wingtips. Most of the Twin Otters are near that mark now, including the one at Iqaluit. That's a huge expense, and one of the reasons the switch to the Pilatus will cut operating costs by 45 percent.

But is the RCMP saving money while sacrificing safety? Dave Brown thinks the Pilatus is a great airplane but the wrong one for the high Arctic. "It would be great down south," he says, meaning the Canadian provinces. He acknowledges that the PT-6 turbine engine has been very reliable in the Twin Otter, and points out that the Pilatus uses an improved version of the same engine. "Still," he says, "my reports show 16 failures, like oil pressure problems, on the PT-6 in four months. None of them catastrophic, but if you get an oil warning light between here and Pangnirtung, where are you going to go?"

Last May a crew flying a Pilatus PC-12 for Kelner Airways faced such a decision. Having taken off from St. John's, Newfoundland, the Pilatus was on its way to Goose Bay, Labrador, when an oil pressure warning light came on at 22,000 feet. The pilot headed back to St. John's and started a descent, but at 16,000 feet the engine was vibrating so violently that he had to shut it down; while he attempted a restart, it cut out completely. After requesting direction to the closest airport, which was 20 miles away, the pilot brought the Pilatus down through a thick layer of clouds. When the airplane emerged from the overcast, however, the airport was nowhere to be seen, and the pilot crash landed in a marsh. Fortunately, no one was killed.

Engineer Dave Brown keeps the Twin Otter assigned to him in good working order, so that pilots like Bob Sellinger (top) won't have to make emergency landings in the harsh Arctic environment.

When asked to comment on the accident, Dave Brown says, "I don't think I better say anything about that." Dave Sperry, however, is willing to talk. "There is some controversy with our own pilot group in terms of their own feelings, as there would be in any aviation group," he says. "And I suppose that perhaps [the Kelner accident] might have reinforced something in their minds. But from an air services management point of view, yes, we're very aware of that incident, and that does not change our management decision at all." (Two PC-12s are now in service with the RCMP.)

Kember, who is now the director of sales for Pilatus aircraft in Canada, reminds me to put the risk of a catastrophic engine failure into perspective. "One of the most likely causes for losing an engine in this kind of work is dirty fuel, and then you'd likely lose both engines in the Twin Otter anyway," he says. "If the worst happens, at its cruising altitude of 25,000 feet, the Pilatus can glide for more than half an hour before it reaches the ground. That gives you a 120-mile circle in which to find a place to put down." At this moment I'm looking out over ice as far as I can see in the moonlight, and I'm tempted to get out the chart to see what there is inside a 120-mile circle with us in the middle.

While we're still out over the ice, Sellinger

points to the south and says, "Northern lights." During the next hour, light begins flashing out of the glow, and soon huge columns of light seem to be rising to about 14,000 feet. Later the columns form into colored prisms that march and shift across the southern sky. It's a breathtaking display. I never thought I'd be far enough north to have to look south for the northern lights.

Though the northern lights occur above the stratosphere, they can appear to be right in front of you. Says Sellinger: "On a very dark night with a particularly brilliant display, you might even experience a little vertigo from all the shifting light. It's good to have the autopilot on so you can just sit back and watch." As we touch down at Iqaluit, I'm wondering whether the show would look the same if you were flying at 25,000 feet in a Pilatus instead of at 8,000 feet, where the Twin Otter hums along.

Undeniably, the Pilatus is sleek and beautiful, with a low wing, retractable gear, pressurized cabin, and a cockpit full of bells and whistles. But when I see the Pilatus later down south, I notice that the prop is badly pitted by gravel. (It's mounted much closer to the ground than those on the Twin Otters' big old high wings.) And Sperry admits that the Pilatus hasn't yet been tested in the extreme cold of the Arctic winter. "The cockpit displays are supposed to be guaranteed to minus 55 degrees, but we won't really know how it functions until it's been in service for a while," he says. Kember adds: "We had a similar period of adjustment with the Twin Otter and every other airplane we've ever used up here. We learn what the quirks are and devise tricks to take care of them." On the Pilatus' first trip to the Arctic, the flaps froze. "The pilots were in a panic because they thought we'd be turned off," says Kember. "But I'd have been surprised if an airplane that had been lubricated for flying in Florida worked perfectly up here."

Resolute Bay is the jumping-off point for travelers making expeditions to the North Pole.

Though they've served admirably for nearly 30 years, the last of the Mounties' 10 Twin Otters will be retired shortly after the turn of the century.

Either way, the long line of de Havilland aircraft serving in the Arctic is coming to an end, and one wonders: Will the Pilatus ever inspire the trust, even the love, that scores of pilots since 1949 have lavished on the Beaver, the Otter, and the Twin Otter? Whatever happens, there is one constant: the intense cold that petrifies tires, freezes autopilots, and ravages unprotected skin. De Havilland airplanes have found a way to thrive in the Arctic, establishing a tradition of bringing their occupants back safely. A hard act to follow.

Saint YURI

by Tom Harpole

SOVFOTO

Photographs by Caroline Sheen

The Russians made their first cosmonaut a hero. Did they really know him?

"I don't believe in God, but I believe he can punish us," Alexei Leonov says with a wan smile. It has been 30 years since his friend and fellow cosmonaut Yuri Gagarin died in a MiG crash, and Leonov still can't reconcile the loss. "We were all fighter pilots. Every fighter pilot has lost friends," he says and shrugs. "Cosmonauts know they are at risk. But Yuri's death is still felt keenly."

We are driving through the Smolensk region, several hours west of Moscow, on our way to Gagarin City for a symposium at which Leonov will speak. The occasion is the 30th anniversary of the day that Gagarin and pilot-instructor Vladimir Seryogin died on the last refresher flight Gagarin was to make before resuming solos in jet fighters. Leonov's unresolved grief echoes that of millions of Russians: No explanation of the events that led to the First Cosmonaut's death has ever been universally accepted.

The symposium is held in a converted Orthodox cathedral painted completely white inside and out. Under the vaulted arches of the high ceiling, the speakers on the ad hoc panel make no progress toward satisfying the unanswered questions. Eight aviation experts and academicians, including General Sergei Belotserkovsky, the octogenarian dean of the Zhukovsky Academy of Aeronautical Science, where Gagarin studied engineering, hash over their theories once again. A few in the audience—which consists of space professionals, journalists, amateur historians, and aficionados—interrupt the panel, hotly denouncing the system that they believe let Gagarin die.

But the panel also is there to lionize Hero of the Soviet Union Number 11,175—the number stamped on Gagarin's medal (signifying, as he liked to say, that 11,174 people were at least as heroic as he had been). Belotserkovsky poignantly reminds everyone that Yuri's personality still affects the cosmonauts, that they all try to emulate his smile, his positive energy.

The panel members listen to any and all comments from the floor with the

patience of priests. They understand the audience's frustration with questions surrounding Gagarin's death; some on the panel have been seeking the truth themselves for 30 years. At day's end, the dispirited consensus is that the untrustworthiness of governments past and present makes any official explanation suspect.

This much is certain: Within half an hour of takeoff from Chkalovskoye airbase outside Moscow on the morning of March 27, 1968, Gagarin lost control of his MiG-15 trainer. By 10:31 a.m., he and Seryogin were dead. The panel acknowledges that the pilots were given poor information on the altitude of the cloud cover. The meteorological report told them that the cloud ceiling was 2,300 to 3,000 feet high. In fact, the clouds were only 1,400 feet above the ground. When they broke out beneath the clouds at nearly 400 feet per second, the pilots had only a couple of seconds to see the dense forest rising toward them. Neither man attempted to eject. Seryogin—a World War II ace, test pilot, and hero of the Soviet Union—was in the back seat and would have had to eject first, abandoning Gagarin to his own devices.

Within a few days of the crash, the woods where the MiG broke up in waist-deep snow had been meticulously combed for the pilots' remains and pieces of the airplane. Investigators claim to have compiled a 29-volume report on the fatal flight. That neither the material evidence nor the report has ever been released to the general public has fueled rumors on the cause of the crash. Some say the men hit a goose or a weather balloon. Some say the CIA poisoned them, others say Gagarin worked for the CIA. Some believe the cosmonaut's immense popularity posed a threat to Leonid Brezhnev and his Politburo accomplices, who had ousted Nikita Khrushchev a few years earlier and resented reminders of past triumphs.

Leonov and Belotserkovsky both subscribe to yet another theory, that another jet violated the MiG's airspace and the vortex of its wake threw the MiG into a spin. In any case, as Leonov points out, Gagarin's death is surrounded with as much mystery and controversy as John Kennedy's.

On the return trip to Moscow, Leonov reflects on the landscape outside the window of his chauffeured Chevy Tahoe. "There used to be farms and villages everywhere around here," he says. "All these berioza [birch] trees are growing where peasants used to cultivate flax. These trees all grew up here since World War II, when the Germans came through the Smolensk region and destroyed 600 villages." He pauses. "Those were the formative years in Yuri's life."

Leonov was born in 1934, the same year as Yuri Alexeyevich Gagarin. Both men were among the original 20 pilots chosen in 1960 for the Soviet cosmonaut corps, out of 2,200 candidates. Gagarin was the first to orbit Earth; Leonov, the first to walk in space.

Gagarin's life wasn't exactly a "little Ivan becomes Czar" story, Leonov says, but it came pretty close. He was a peasant's son, born in the village of Klushino. "He was very proud of his family," Leonov says. The day after his orbit the New York *Daily News* reported that he was kin to Russian royalty, a nephew to Nicholas II. Gagarin, in an uncharacteristically acerbic response to the Russian press, said that this was stupid: He was a simple peasant.

Yuri was seven years old when World War II spilled into Russia. Years later, members of his family would recount to biographers the indignity and terror of lodging a German soldier in their log house. One day "the Devil," as the Gagarins called him, tried to hang Yuri's older brother Boris by his scarf from a tree until the boy's mother scuffled with the soldier and cut down her almost dead son. A few weeks later, in retaliation, Yuri disabled the German's motorcycle by stuffing garbage into the exhaust pipe.

In 1945 Gagarin's family moved to the village of Gzhatsk (now called Gagarin City), where Yuri completed his primary education. At 16 he took a job in a foundry so that he could send money home. He quickly became an accomplished welder and was sent to an industrial training school at Saratov. It was there that he joined a flying club and flew his first solo. Eventually he was accepted to the Air Force training school at Orenburg in southern Russia and graduated as a fighter pilot in 1957, the year the Soviets launched the first Sputnik. After honing his flying skills in Yaks and MiGs, Gagarin was sent in 1959 to Bordenko Military Hospital in

Among the dozen or more Gagarin monuments in and around Moscow is this statue in Star City, where the cosmonauts live and train. Thirty years after his death, many members of the cosmonaut corps still look to Gagarin as a role model.

VALENTIN CHEREDINTSEV/TASS

Moscow to determine, he was told, if he was a suitable candidate to test a new "super vehicle."

It is said that his selection to be the first man in space had much to do with his smile. In photos the smile is always present, but it wasn't practiced or disingenuous. Among those smitten by Gagarin's natural charm was Chief Designer Sergei Korolev, the rocket engineer who masterminded the early Soviet space program and played a key role in choosing the cosmonaut crews. Leonov remembers that when the first group of 20 cosmonauts were introduced to Korolev in June 1960, the designer spent more time talking to Yuri than to any of the rest.

Above: Yuri with fellow space pioneers Valentina Tereshkova and Alexei Leonov in 1967, and striking a pose as captain of the Star City hockey team (right). Written in chalk on his sweater is the Russian word for "Ours." Sergei Kiselov (below) taught Gagarin to skydive and was one of many friends who benefited from his generosity.

"Korolev was aware that the first man to orbit would be a great propaganda tool, and that he needed a certain presence. But Yuri was the obvious selection for more reasons than his looks—many more," says Boris Volynov, another of the original cosmonauts.

"The original [cosmonauts] were all interviewed occasionally, one by one, and asked to assess who should be first. We all had our strengths, but if you honestly appraised the one with a composite of strengths, everyone agreed that Yuri was the best choice," according to Volynov. "In every aspect of training he excelled. He was a master parachutist, he thrived in survival training, he could take more Gs in the centrifuge than anyone, he'd emerge from days of isolation in the baric chamber smiling. Even in the study of celestial navigation, Yuri was ahead of us. He was a leader, but he did everything graciously and with that relaxed smile, and no one resented him."

BORIS ALEXEYEVICH SMIRNOV

No one, that is, except Gherman Titov, who as backup for the inaugural flight would forever remain in Gagarin's shadow. "Perhaps the only one who still maintains that he should have been first is Gherman Titov," Volynov says with a smile.

Yuri Surinov, who supervises physical fitness training at Star City, the cosmonauts' village outside Moscow, remembers Gagarin the athlete. "When you see people at play in games such as hockey and basketball and volleyball, a lot is revealed about their personality," he says. "Yuri was the peacemaker in hockey. He was small, but the best basketball player the cosmonaut corps had, with quick reflexes. Even after he became famous he didn't want to be a star. He wasn't aggressive, but when he made a mistake he took himself to task quietly. He brought other people up to his level of intense playfulness."

The apparent simplicity of Gagarin's Vostok 1 mission—a single orbit, with no piloting required—belies the real risks it posed. In 1961 spaceflight was at best an evolving science. Very little was known about the consequences of subjecting humans to weightlessness for more than a brief period. The cosmonauts had experienced microgravity for only two or three seconds at a time in a freefall elevator ride at the 28-story Moscow University. "We didn't even know if we could swallow while orbiting," Leonov recalls.

Moreover, the spotty performance of Soviet space hardware was cause for grave misgivings. Korolev's "Cannonball," the spherical Vostok capsule in which Gagarin was to orbit, had been tested—with dogs and dummies—for less than a year. On its first outing, in May 1960, a faulty sensor led to a botched reentry. Of the next four launches, only one was a success. Gagarin and Titov, on an orientation tour of the Baikonur launch complex in July, watched an R-7 rocket, which was to be their launch vehicle, blow up shortly after liftoff, killing the two dogs on board.

Despite the mishaps, Korolev believed his engineers were learning from

A futuristic 10-story statue of Gagarin dominates the modern skyline over Moscow's Leninski Prospect. Soviet rocket designer Sergei Korolev (below, right, with his wife and the Gagarins on vacation in 1961) treated Yuri like a son and had a major say in picking him for the first spaceflight.

failure, and he pressed ahead with trials of a man-rated version of the Vostok capsule. After a flawless March 9, 1961 test returned a life-size mannequin to Earth along with a dog and some other animals, Korolev, still troubled by the failures of the previous year, called for one last test, using another dummy. The March 25 flight made a single orbit in 115 minutes and returned safely to a site near the city of Izhevsk.

The human passenger for the Vostok 1 flight wasn't selected until the week before launch. Gagarin, Titov, Grigory Nelyubov, Andrian Nikolaev, and Pavel Popovich all arrived at the launch site in Baikonur on April 5, 1961, uncertain as to who would be the first man to venture into orbit. A committee that included Korolev made its decision known on April 8: Gagarin, with Titov as backup. To the other cosmonauts it was no surprise. Early on the chief designer had shown a special interest in Yuri. But the choice was affirmed by other committee members, including Nikolai Kamanin, the stern director of cosmonaut training, who had reached his conclusion independently.

Gagarin's wife, Valentina Gagarina, recalls in her memoirs that on April 11, the day before his launch, in a ploy to keep her from worrying, Yuri phoned her from Baikonur and told her that on April 14 he would be involved in something big. It wasn't until midday on the 12th, when a neighbor told her to turn on the radio, that Gagarina learned that her husband had orbited Earth. By then the news of Yuri's feat was circling the globe faster than his Vostok sphere.

BORIS ALEXEYEVICH SMIRNOV

If Gagarin felt any apprehension about his flight, it didn't show. Transcripts of his radio communications with the ground, published for the first time by a Russian newspaper in 1991, were full of breezy banter. Asked if he was bored during the final minutes of the countdown, he joked, "If there were some music, I could stand it a little better." When a nervous Korolev asked: "How do you feel?" a minute and a half into the flight, the first man ever to ride a rocket into space answered back, "I feel fine. How about you?"

Although he stayed busy monitoring onboard systems during his one-hour

While other Soviet-era personalities have been removed from public view, Gagarin's face still appears everywhere: in folk art, on the covers of books and record albums (right), in city squares (below), and beaming down from a Moscow street mural depicting historic Russian triumphs (opposite, bottom).

48-minute flight, Gagarin had time to enjoy the view. "It is beautiful, it is beautiful," he said, looking at Earth. He ate and drank, lost his floating pencil, and reported feeling good as he watched the sun rise over North America.

The end of the flight, though, came closer to disaster than the world knew at the time. The Vostok sphere was supposed to separate cleanly from its equipment module, but the two remained tethered by an umbilical line, which set Gagarin tumbling at 30 degrees per second. "I was an entire 'corps de ballet'—head, then feet, head, then feet, rotating rapidly," he reported later. He also experienced about 10 Gs, more than expected, until the umbilical cord finally burned through and freed his capsule. Ten minutes of unanticipated tumbling must surely have rattled the Vostok's first passenger. But in a debriefing session with Korolev, Kamanin, and other space officials the day after the flight, Gagarin played down the episode, saying, "I reasoned that it was not an emergency situation."

Gagarin was ejected from his capsule at 23,000 feet and landed under two parachute canopies in a plowed field—a fact that he always had to lie about since, according to the rules of the Federation Aeronautique Internationale, the pilot was supposed to land with his vehicle to be able to claim a "complete flight" for the record books. He shrugged off his parachute harness and walked awkwardly toward a peasant woman and her granddaughter, introduced himself and explained that he was a Soviet who had come from space.

Until that day, every aspect of the Vostok program had been carried out in the total secrecy that characterized military projects behind the Iron Curtain. But by the evening of April 12, Gagarin was one of the most famous names on the planet. In his home country, photos and articles about the world's first space traveler were splashed across the pages of *Pravda* and *Izvestia* for five days, until news of the Bay of Pigs invasion bumped it.

Yuri's legend, though, kept growing with help from the Communist propaganda machine, which began distributing millions of pictures of the photogenic hero: Gagarin planting a tree, lifting weights, riding a bicycle, looking at flowers, holding a dove, wearing a skydiving rig, watching television with his mother, surrounded by children in a classroom, mixing with workers in a factory lunchroom, playing ice hockey.

"He was a god on Earth who got a sackful of mail every day," says academician Sergei Belotserkovsky. Gagarin eventually had to have his own Moscow postal code and staff for handling correspondence. Rather than dismissing the thousands of "begging letters" he received, he used his influence to resolve every case he could. Sergei Kiselov, one of Gagarin's skydiving instructors, attributes the fact that he can still walk to the cosmonaut's intervention. Kiselov broke his neck when he landed with a heavy camera strapped to his helmet after filming some skydivers in freefall.

He was hospitalized with paralysis in his legs, and Gagarin, over the protests of the military doctors, arranged to have him moved to a private hospital in Moscow reserved for the Communist party elite.

Ironically, his influence didn't extend to his own career. Gagarin was the smiling face behind the greatest technological coup of his time, and his value as a propaganda tool far surpassed his usefulness as a pilot of space vehicles or military jets. Nikolai Kamanin refused to let Gagarin add to the meager 250 or so hours he had accrued as a fighter pilot before joining the cosmonaut corps. Instead, Yuri began to refer to the Ilyushin passenger jet that ferried him around the world as "home."

Meanwhile, his less celebrated colleagues got to fly in space. Gherman Titov orbited four months after Gagarin, and returned complaining of the first case of space sickness, leading Soviet scientists to suspend Vostok launches for a year while they studied the problem. On August 11, 1962, Vostok 3 was launched with Andrian Nikolaev aboard. Pavel Popovich followed a day later in Vostok 4, then flew to within four miles of Nikolaev for a near-rendezvous in orbit. Despite their accomplishments, Titov and the rest slipped into relative obscurity, while Gagarin toured the world collecting laurels.

YU. TUMANOV, ITAR-TASS/SOVFOTO

Gagarin addresses a crowd in Lenin Square in June 1961, two months after his first and only spaceflight.

In the seven years between his first orbit and his fatal airplane flight, Gagarin's face—which rivaled the Beatles for worldwide recognition—grew fleshy; his athlete's belly swelled. He visited 28 countries, and the countless state dinners and banquets took their toll on his physique. The high life led inevitably to gossip. "Yuri tolerated his fame and was equal to his fate as one of the most famous people on Earth," says Irina Solovyova, a former cosmonaut and now a Star City psychologist. "Of course, as a luminary he was watched, and people constantly speculated on his personal life." She dismisses the notion that he was an alcoholic and philanderer, preferring to focus on his more admirable qualities. "Star City is a small place," she says. "If someone was having those kinds of problems, we would know it."

But there are too many stories to ignore. Five months after his Vostok flight, at the Black Sea resort of Foros, Gagarin injured his left eye and forehead when he jumped from a window after his wife caught him with a young nurse. In 1968, the year Gagarin died, a worried Nikolai Kamanin wrote in his diary: "There were many situations when Gagarin miraculously escaped big troubles. These situations often occurred when he attended parties, drove in cars or boats, or when hunting with the big bosses.... The active life style, endless meetings and drinking sessions were noticeably changing Yura's image and slowly, but steadily erasing his charming smile from his face."

Nonetheless, by all accounts he remained a devoted husband and father. Valentina Gagarina's feelings are unknown—almost 40 years later, she still grants no interviews.

Gagarin's Star City comrades don't like to dwell on his transgressions. He is remembered instead as a good friend, a fair boss, and a dedicated engineering student (he graduated with an advanced degree from the Zhukovsky Academy a month before he died, after turning in a thesis on winged spaceplanes). Barred from flight himself, he did what he could to help his colleagues. In 1962 he was given the job of supervising training for five women cosmonauts, which led to Valentina Tereshkova's flight in June 1963. Six months later he became deputy director of the cosmonaut training center. By September 1966 Khrushchev was long deposed and Korolev, Gagarin's mentor and champion, was dead. In a perverse twist, Soviet authorities finally allowed him to train for another spaceflight because they no longer wanted him for propaganda purposes.

While a few cosmonauts grumbled that he had pulled rank to jump ahead of the queue, Gagarin threw himself into his role as backup for Vladimir Komarov's Soyuz 1 flight. Serious problems with the new spacecraft quickly became apparent, however, and what was supposed to be a historic docking

Saving Colonel Komarov

In their recent biography of Gagarin, Starman, *British authors Jamie Doran and Piers Bizony tell the story—largely based on the recollections of Gagarin's KGB handler Venyamin Russayev—of the First Cosmonaut's attempt to stop the disastrous launch of Soyuz 1, which claimed the life of cosmonaut Vladimir Komarov. Gagarin, Komarov's backup for the flight, knew that his friend would likely die on the flight. So did Komarov, who broke down and confessed to Russayev a few weeks before launch, "If I don't make this flight, they'll send the backup pilot instead. That's [Yuri], and he'll die instead of me." But top Soviet officials wanted a launch to commemorate the 50th anniversary of the Communist revolution, and that was that. Before the flight, Gagarin and other cosmonauts prepared a document detailing more than 200 technical problems with the new Soyuz spacecraft and gave it to Russayev to deliver to party higher-ups. In classic shoot-the-messenger style, Russayev was sacked without the letter even leaving KGB headquarters. The launch went ahead as planned on April 23, 1967, and Komarov crashed and burned to death when the Soyuz's parachutes failed to open on landing. According to Doran and Bizony, the incident taught Gagarin a bitter lesson about the limits of his influence:*

The Gagarin of 1967 was very different from the optimistic and carefree young man of 1961. Komarov's death had placed an enormous burden of guilt on his shoulders. "He told me the story about the huge research effort undertaken to try and prevent the flight," says Russayev. "He said the results were supposed to have been reported to the Main Man [Leonid Brezhnev]. He explained how they'd thought of me as an envoy in charge of getting the letter to the relevant offices. I told Yuri how I'd worked on it, and everything that had happened…He warned me, "Walls have ears." It was Yuri's idea to avoid the lifts. Somebody must have told him my apartment was bugged…"

At one point Gagarin said, "I must go to see the Main Man personally. Will he see me, d'you think?"

Russayev says, "I was amazed he could ask me this. I said, 'But Yuri, you're the one who's always standing next to him on the Mausoleum. You're always chatting together, and now you're asking me if I can tell you whether or not he'll see you? I haven't even shaken the guy's hand."

" 'Yes, but I never talk seriously with him. All he ever wants to do is hear dirty stories and jokes from all my foreign trips.' "

Gagarin was profoundly depressed that he hadn't been able to talk properly to Brezhnev and persuade him to cancel Komarov's launch. As Russayev explains today, "Relations between Khrushchev and Gagarin were absolutely excellent, but with Brezhnev it wasn't so good. If people don't want you, it can be hard to get through."

Shortly before Gagarin left, the bitterness and intensity of his anger became obvious. "I'll get through to him [Brezhnev] somehow, and if I ever find out he knew about the situation and still let everything happen, then I know exactly what I'm going to do."

Russayev goes on, "I don't know exactly what Yuri had in mind. Maybe a good punch in the face."

Russayev warned Gagarin to be cautious as far as Brezhnev was concerned. "I told him, 'Talk to me first before you do anything, and I'll try to advise you. I warn you, be very careful.' But I wasn't in the space department any more. I wasn't even in Moscow, so there wasn't much I could do. I don't know if Yuri ever got to see Brezhnev, and I've felt guilty ever since that I couldn't stay with Yuri to guide him."

One story has it that Gagarin caught up with Brezhnev eventually and threw a drink in his face.

—Jamie Doran and Piers Bizony

mission timed for the 50th anniversary of the 1917 Revolution instead resulted in death and disaster (see "Saving Colonel Komarov," above).

Gagarin's inability to stop Komarov's fatal flight brought him face to face with the corrupt Soviet system from which he had benefited. Compounding the emotional strain of knowing a friend's life was squandered, the Star City bosses again grounded him from rocket flights due to renewed fears of a fatal accident. But within a few months he prevailed on his superiors to be allowed to fly aircraft, writing: "If I stop flying I will have no moral right to lead other people whose life and work are connected with flying."

The day he died Gagarin's office was sealed; eventually it was reassembled in the museum at Star City. Among the books on his shelves were a history of art, a volume of poetry, *The Art of Flight,* books on astronomy, cosmonautics, and philosophy, a WW II manual on how to ram other airplanes when you run out of bullets, and his memoir, *The Road to Space.*

On his plain wooden desk was a scrap of paper with some notes, in his hand, about his schedule on March 27, 1968, after the flight with Seryogin. The rest of his day was to have included meetings with civilian pilots, followed by arranging flight training schedules for transport pilots. On that scrap is a doodle smaller than a shirt button. The tiny sketch has a dark center with petals that increase in size as they spiral out from the center. It's an exquisite design, and Gagarin's steady hand never lifted the pen as he rendered it. Later that day he did not lift his hand from the control stick of his MiG as it hit the ground at 450 mph. Investigators know this because of the way the bones in his hands were broken. He had not given up trying to fly.

"He was a peasant's son, he really was, but he rose to the top of the cosmonaut corps because he was willing and worthy and he was a good man,"

BORIS ALEXEYEVICH SMIRNOV (2)

March 1968: Cosmonaut Valentina Tereshkova shows a grieving Valentina Gagarina where her husband's MiG came down (far left). Broken trees and a hole punched in the ground testified to the violence of the impact.

Irina Solovyova says of her friend. "He became a big boss but never became arrogant, never became self-conscious about his beginnings. After his flight the image of cosmonaut meant a lot."

The day after the symposium at Gagarin City, on the 30th anniversary of Gagarin's death, Leonov attends another memorial service some 40 miles northeast of Moscow, in the forest where his friend's jet crashed. He points to a clump of birch trees: "See the broken tops, where the trees have grown bushy: that's where they came down."

Today a 30-foot polished granite obelisk with relief carvings of Seryogin and Gagarin marks the site. Some 4,000 people, bundled up against the lingering winter weather, show up to honor the memory of two Soviet heroes. Several hundred of them knew Gagarin: cosmonauts, scientists, instructors, technicians from Star City and other space centers. But many who come to pay their respects could not have known him personally. The newest generation of cosmonauts in attendance have only seen pictures of him. Scores of schoolchildren climb trees and stand on the raised berms of plowed snow at the edge of the ceremony so that they can get a better view.

V. SAVOSTYNOV, ITAR-TASS/SOVFOTO

After the accident, thousands flocked to pay their respects to Gagarin and copilot Vladimir Seryogin in the Central House of the Soviet Army (above). Russians of that generation, like the woman tending a garden near one of the monuments in Star City (below), still cherish the First Cosmonaut's memory.

In an era when the statues of Communist politicians, military figures, and other Soviet heroes have been torn down and piled like cordwood in Moscow's Gorky Park, when more than 160 streets in Moscow that were named after cold war icons and other notable Soviets have reverted to their original names, every capital city from the old U.S.S.R. still displays at least one monument to Yuri Gagarin.

On this day his memory evokes passionate speeches, several poems, an original song by folksinger Josef Kobzon, and tears. As hundreds of people queue up to lay floral wreaths at the monument, an 11-year-old girl slides down from a pile of snow, looks me in the eye, and shakes my hand. Her name is Olga, and she tells me quietly, in English, that she studied Yuri Gagarin in her history class. "World history or Russian history?" I ask. "World," she answers. "He belongs to world."

Editors' note: October 14, 1947, was a day of undercover celebration at the Muroc Army Air Field in California's Mojave Desert. Captain Chuck Yeager had broken the so-called sound barrier in the experimental Bell XS-1, and the news was immediately locked away in the vaults of the newly independent U.S. Air Force and the National Advisory Committee for Aeronautics. Although the X-1 program was classified and there were no independent observers, Yeager was able to claim an official record because all airspeed, Mach number, pressure, and temperature data from test flights were tracked, recorded, and documented. Such documentation, like that produced by the Wright brothers, who painstakingly recorded all details of their flights, ensures an unassailable place in history.

But there was another high-speed experimental aircraft flying over the desert that autumn. And although claims that the North American XP-86 achieved Mach 1 are merely anecdotal, Al Blackburn, a former North American test pilot, interviewed eyewitnesses, researched historical accounts, and reconstructed the events of those memorable months in the book Aces Wild: The Race for Mach 1 *(Scholarly Resources Inc., © 1998, 800-772-8937, $24.95), from which this excerpt has been adapted.*

MACH MATCH

Did an XP-86 beat the X-1 to the punch?

by Al Blackburn

Going supersonic for the first time is clearly a historic aeronautical event, just as the Wright brothers' first flights are. But I can never remember which brother did it first. They did it on the same day, and whether it was Wilbur, then Orville, or Orville, then Wilbur, doesn't seem to matter much. In the supersonic event, was it George Welch, then Chuck Yeager, or Yeager, then Welch? Looking at the record, it could have been Welch by a fortnight or Yeager by four weeks.

A North American XP-86, prototype for the U.S. Air Force's first swept-wing fighter, takes off on a test flight over the high desert of California. At about the same time, the Bell X-1 was preparing to become the first aircraft to exceed Mach 1.

AFFTC HISTORY OFFICE, EDWARDS AIR FORCE BASE

COURTESY NORM AVERY

The fall of 1947 in California's Mojave Desert was an incandescent time to be alive—for the crazy-ass pilots who were testing myriad new aircraft and for the lovely, loving, hopeful ladies who attended their safe return. So soon after the war, the prevailing mood was akin to the euphoria of victory but blessed with much smaller casualty lists. Much of the exhilaration centered on a little orange rocketship being sent aloft from Muroc Army Air Field with growing frequency, attached to a B-29 mothership. Everyone knew that this represented a substantial national effort, bringing together the resources of the U.S. Army Air Forces (soon to be renamed the U.S. Air Force), the National Advisory Committee for Aeronautics, and the Bell Aircraft Company to launch the first manned aircraft designed solely to fly faster than sound.

The word from the X-1 camp at Muroc was that Army Air Forces Captain Chuck Yeager had come very close to going supersonic on September 12. Surely on the next flight he would push it through. But then the X-1 flights were postponed. Rumors of a serious pitch control problem drifted out of the Bell camp. There was evidence of a lot of scrambling. Yeager was pressing fellow pilot and engineer Jack Ridley, the one man on the X-1 team in whose hands he'd entrust his life. He wanted Ridley's assurances that the changes would work—he wanted no more running out of pitch control at Mach 0.94.

North American test pilot George Welch could only smile as these tales leaked out of traded confidences. His money was on another contender. The first XP-86 aircraft, Army Air Forces serial number PU597, was rolled out of his company's plant in Los Angeles on August 8. The more involved Welch had gotten in the development of the Sabre, the more he was convinced that he could capture the laurels of the first supersonic flight for North American Aviation.

Welch had joined North American in the middle of 1944, at the height of the war and the peak of demand for North American's prime product, the P-51 Mustang. He'd been there only a month or two when Fred Borsodi visited from Wright Field and showed his film of shock waves on a Mustang's wings as it dove at max power straight down from 40,000 feet. Theodore von Kármán, the legendary aerodynamicist from the California Institute of Technology in Pasadena, was at that screening, and observed that when an entire aircraft, not just the air accelerating over the thickest part of the wing, went supersonic, shock waves would be sent to the ground. He theorized that people nearby would hear and feel the passing of that pressure pulse. Listening intently to all this were Ed Horkey, a former student of von Kármán's, and Harrison Storms and Larry Greene, who were leaders in the aerodynamics section of North American's advance design group. Another observer was George Welch.

SAN DIEGO AEROSPACE MUSEUM

After completing extensive ground testing at North American Aviation's Los Angeles facility (opposite), the XP-86 was disassembled and trucked to Muroc for its first flight. NAA test pilot George Welch (opposite, bottom) had kept close tabs on the project and thought the aircraft capable of busting Mach 1 before Captain Chuck Yeager (below, at left) and the Bell X-1 did.

Over the next three years, Welch stayed in touch with Horkey, Storms, and Greene as they created the XP-86. And he spent time with Walt Spivak, who had cut out the pieces and put them together on the shop floor. Welch also spent a lot of time in the Sabre's cockpit at Muroc and observed the flight test crew as they checked out all the systems and instrumentation for this sleek new fighter.

Welch knew that the engineers had carefully reviewed the analytical data and wind tunnel test results the Germans had obtained from their swept-wing designs, and that North American had also run its own wind tunnel tests. Storms told him that they were almost certain that top speed at altitude would be better than Mach 0.9 in level flight. He explained to Welch that at that Mach number, the center of lift would start to move aft on the wing and that he would have to pull back on the stick and start trimming...but very carefully. Changing the angle of the whole stabilizer at that speed and a changing Mach number could get pretty tricky.

"So I'm doing nine-tenths at, say, 35,000 feet and push the nose over into a 25- to 30-degree dive. What then?" Welch asked the designers.

Greene couldn't contain himself. "By 30,000 feet you're supersonic."

"What's the risk?"

Greene shook his head. "We really don't know. Our best guess is that it's not very great."

"My guess is virtually zero," Welch said. He described a recent visit to New Mexico, where he'd spent the night just south of the Army's White Sands Missile Test Range. Another group of experimenters there were launching V-2 missiles brought from Germany. Welch talked to several men who had witnessed some launches, and they told him about the blasts of shock waves that hit the mountain top about 30 seconds after each V-2 had taken off. "A big ba-boom just like von Kármán predicted," Welch said. "Hell, that V-2 is bigger than the Sabre, or the X-1 for that matter, and it slides through the so-called sonic wall like a surfer riding a big wave." Welch thought that too big a deal was being made over faster-than-sound flights, a theory he intended to test.

Welch came to Muroc in September and stayed at his usual hangout, Pancho Barnes' Fly Inn, later to be named the Happy Bottom Riding Club. It comprised some 400 acres bordering Muroc Field on the south. In addition to rooms, there were suites, a restaurant, a bar, a swimming pool, riding stables, and an airstrip. Many of the North American crew would show up—flight test supervisor Roy Ferren and flight test mechanic Bob Cadick—as well as members of the X-1 team: NACA leader Walt Williams, Jack Ridley, Chuck Yeager, and Bell project engineer Dick Frost. The usual bevy of Pancho's down-on-their-luck ladies added their own leaven of lust and luster in more or less equal measure. Pancho herself was unique. Born wealthy of distinguished forebears, she chose what might be called today an alternative lifestyle. Her friends included Jimmy Doolittle, Chuck Yeager, Buzz Aldrin, and many of the Hollywood set, for whom she had done stunt flying in the early days of aviation films. Her conversation was punctuated with obscenities that would make a boatswain's mate blush.

Among the ladies at Pancho's, Welch had formed a special relationship with one Millie Palmer. Palmer was quieter and more serious than most of the other girls. When Welch and Palmer had dinner together at Pancho's, he drank less and got to bed earlier.

On Monday evening, September 29, after some XP-86 taxi tests, Welch was at Pancho's having dinner with Palmer. He was quietly pleased at how well the first outing had gone. He noted that the X-1 crowd looked pretty glum. The little rocketship hadn't flown in more than two weeks. Palmer reported the rumor that Ridley was working on giving Yeager more pitch control through the trim mechanism. "It looks as though Wednesday is my big chance," Welch told Palmer. "A supersonic dive is for sure not on the flight card for the first flight, so I'll have to do it without recording data. It's agreed that I'll pull up the landing gear, just to get a feel for how it flies in the clean condition. Without making a record in the usual way, you'll have to be my data bank. If on Wednesday morning you hear a sharp boom like a clap of thunder, be sure and write it down—what it sounded like, what time, reaction from others, stuff like that."

NATIONAL ARCHIVES

The first flight of the XP-86 did indeed take place on Wednesday, October 1. Welch climbed with full power to 10,000 feet above sea level, which was 7,700 feet above the Mojave desert floor. On his wing was North American engineering test pilot Bob Chilton in a P-82 Twin Mustang. The right cockpit of the dual-fuselage fighter was occupied by a cameraman.

In a little more than 10 minutes, Welch had reached 35,000 feet. Leveling out, he watched the indicated airspeed climb to 320 knots. He estimated that should be Mach 0.90. He had been heading east and was just passing over the El Mirage dry lake. Rolling into a 40-degree dive, he turned to the west. His aircraft was pointing at Pancho's hacienda, several miles south of Rogers Dry Lake. The airspeed indicator seemed to be stuck at about 350 knots, but the Sabre was behaving just fine. At 29,000 feet there was a little wing roll. Correcting the roll, Welch pushed into a steeper dive. The airspeed indicator suddenly jumped to 410 knots and continued to rise. At 25,000 feet he brought the Sabre back to level flight and reduced power. The wing rocked again and the airspeed jumped from nearly 450 back to 390. Welch pulled up into a barrel roll to the left followed by one to the right, not unlike the victory rolls used in the recent war by returning fighter pilots to let their crews know they had bagged an enemy aircraft.

Before he left for Los Angeles to brief the Sabre project people, Welch called Palmer, who reported that a big "ba-boom" had nearly bounced her out of bed. She added that Pancho, a big Yeager supporter, had heard it too but attributed it to some mining operation up in the hills.

(Bell program manager Dick Frost recalled the first boom laid down on the dry lake in February 1947 as Bell pilot Slick Goodlin did his crack-the-whip maneuver in the X-1 model with the thicker wing, pulling 8.7 Gs at Mach 0.80 and snapping back abruptly to negative Gs. It was a sharp crack, not the ba-boom that would later become so familiar over the Mojave.)

After the first flight of the XP-86, Welch dropped into Horkey's office at the Inglewood plant in Los Angeles to talk about some "funny" readings on the airspeed indicator. He explained the "stuck" phenomenon he encountered at 350 knots while accelerating downhill, then the sudden jump to 410 knots, then the drop back to 350 knots as he leveled out at 25,000 feet. Horkey asked if the flight recorder showed anything odd. Welch confessed that the dive wasn't on the flight card. "I was just feeling it out, so I wasn't running the camera," he told Horkey. "You know how brassed off the instrumentation guys get when I run out of film for the landing. Anyway, they said there wasn't anything wrong with the airspeed system. They checked it out after I landed."

Horkey thought Welch may have run into some Mach effects and told him to take another look next time he was up at altitude. (Down the road, before Mach indicators became standard equipment, the only signal to the pilot that the aircraft was going supersonic was the hangup on the airspeed indicator as the shock wave passed over the indicator's static source, followed by the jump in the indicated airspeed. This occurred at various airspeeds, depending on the altitude and temperature at which Mach 1 was exceeded.)

"Meanwhile, I'll see about getting NACA to help us out," Horkey said. "They have that fancy new radar theodolite at Muroc that can tell us how fast, how high, and where you are within a gnat's ass. But we have to get on their schedule."

Welch knew that the new NACA equipment was being used to track Yeager's flights in the X-1. He also knew that North American didn't have a prayer of getting on the theodolite until Yeager had done his thing. Welch was on his own.

On October 9, Welch's wife delivered a baby boy. When she called her mother to announce the birth, she also dropped the news of another blessed event. The new dad had days earlier made aviation history by becoming the first pilot to fly faster than the speed of sound. She made her mother promise not to tell anyone, explaining that it wasn't just a family confidence but a military secret.

One week after Welch pushed the XP-86 over into what he believed was a Mach 1 dive, the X-1 flew at Mach 0.925, faster than the Mach 0.92 achieved on an October 3 flight. But on October 10, Yeager was sure he had done it. Ridley had worked his magic on the horizontal stabilizer trim mechanism and Yeager was certain he had popped

COURTESY NORM AVERY

With tests of the P-82 (left) under his belt, Welch (second from left) turned to the sleek XP-86 (opposite) as a project engineering test pilot with a special agenda. Welch was a loner who did not cultivate friendships with fellow pilots, but he got along fine with airplanes.

NASM

through. The entire X-1 flight test team was at Pancho's that Friday evening waiting for the data reduction people to show up with the official figures. Yeager and Pancho were huddled in a corner. The X-1 pilot had a furrowed brow. He was trying to explain to Pancho that he might not have been pointing toward the Fly Inn when he finally pushed through the big barrier. That might explain the absence of a boom earlier in the day, when he was virtually certain he had finally made the first supersonic flight. When Pancho pointed out that Welch had sure made one hell of a boom more than a week ago, Yeager insisted that it was just a fluke. Pancho arched her eyebrows and noted that it had sure heated up a stable full of fillies at her hacienda.

Then the data sifters showed up, half elated, half despondent. Yeager had gone a lot faster than ever before. He had come as close as you can get and still had not made the ultimate penetration. The most careful analysis showed that on the morning flight, the X-1 had attained Mach 0.997. Another pint of rocket fuel and it would have slid through.

On October 13, Welch called Ferren to check on the status of the Sabre, which Ferren reported would be ready first thing next morning. "By the way, L.A. is insisting that like the last two flights, the next one be made with the gear down," he added.

"We can focus on gear-down tests on the next two flights, but I want the option to retract the gear if I need to," Welch replied, his mind working at warp speed. Why were they doing this? Was the Air Force making sure there would be no more surprise, albeit unofficial, booms?

Early Tuesday morning, October 14, Welch taxied the company Navion onto the ramp of North American's hangar at Muroc's North Base. The XP-86 had already been rolled out. Also on the ramp was the P-82 chase plane. Fellow test pilot Bob Chilton would be flying chase again.

"The Air Force is kinda looking down our throats on this flight, aren't they?" said Chilton. He also knew that Yeager might bust Mach 1 that morning, and, knowing what Welch was up to, noted that there might be an awkward 15 minutes between Welch's reported performance of test card maneuvers and his eventual return to base. He suggested that Welch stretch out the test card, letting the narration over the radio trail the actual performance of the maneuvers. That way, when people on the ground heard a boom, they might think it was Yeager.

Welch climbed to 10,000 feet and ran through the lateral and directional stability checks on the test card, but he reported the results via radio to the North American flight test engineer at Muroc on only half of them. He retracted the landing gear and waited for Chilton to slide underneath to check on his gear doors. Chilton gave him a thumbs-up and Welch advanced the throttle to full military power. During his climb to

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37,000 feet, he kept reading out the results of the tests not yet reported. As he reached his altitude goal, 2,000 feet above the starting point for his successful sound barrier penetration of nearly two weeks earlier, he once more rolled into a dive of at least 40 degrees and headed westward with the nose of his Sabre pointing directly at Pancho's. On the way down, he called out the results of the next to last test point on the card.

Once again he experienced some wing roll as his airspeed indicator hung up, then popped through to greater readings. Because he had started at a higher altitude, the Mach-related transients were less pronounced than they had been on the first flight. Instead of a gentle, throttled-back recovery like he'd flown on that first outing, Welch left full power on and performed a four-G pull-up, little realizing that this would greatly increase the impact of the shock wave aimed at Pancho's place. He carefully throttled back and called off his last point on the test card as though he had just completed it.

Welch had shut down and dismounted and was heading for the locker room to drop his parachute and helmet before debriefing with the flight-test engineers when he heard a distant but distinct ba-boom. His watch read 10:30.

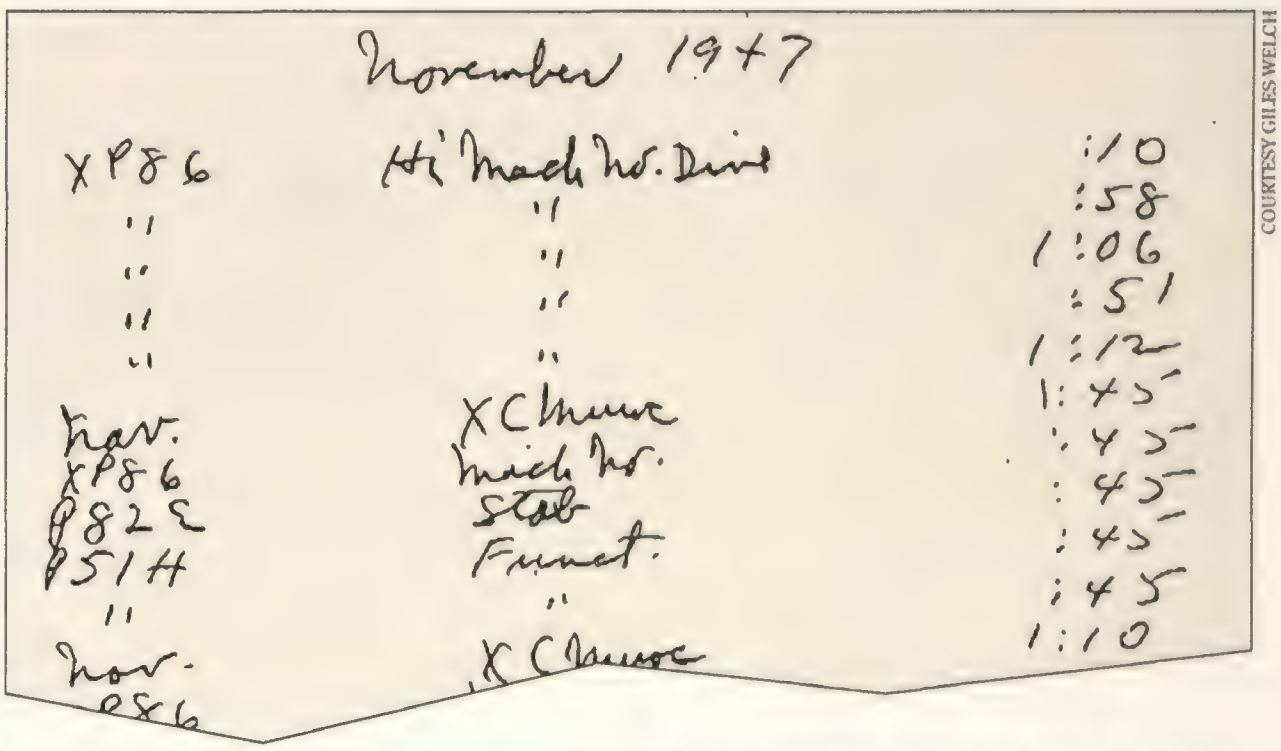
A security clamp was immediately placed on Yeager's penetration of the sound barrier. Consequently, a celebration at Pancho's was out of the question. Instead the X-1 team started their whoop-de-do at Yeager's house, and later, when Yeager ran out of booze, they adjourned to Dick Frost's. It's not that Pancho's closed down for the evening. The North American crew showed up, if only to get a reading from their own highly sensitized boom detectors at Pancho's. Welch and North American pilot Bud Poage were making careful mental notations while ascribing all credit to Yeager and the X-1. Both Millie Palmer and Mona (soon to be Poage's bride) were on hand to provide authentication, especially of the first boom, which cracked a couple of windows in two of the rooms facing east. Major General Joe Swing, a Pancho's regular, found it strange that there were two ba-booms some 20 min-

Pancho Barnes' Fly Inn was the social center of Muroc (below), and the huge spread, comprising restaurant, bar, pool, stables, and airstrip (above), was an ideal target for enterprising sonic boomers.

utes apart. Didn't it take at least two days to get the X-1 ready to fly again? With only four minutes of fuel at best, it certainly couldn't make two ba-booms in such a short interval. Welch shrugged and suggested with a straight face that maybe a V-2 had flown off course out of White Sands.

Welch flew the Sabre the next morning. The following week he made four flights, and the subsequent Monday, October 27, he flew four flights in one day. He then surrendered the Sabre to Bob Chilton for a couple of familiarization flights. Chilton was no shrinking violet. It is entirely possible he laid a boom or two on his own. On November 3, Welch commenced a series of high-Mach dive flights, so labeled in his flight log.

This persistent barrage of ba-booms at the Air Force test base finally precipitated permission to use the high-precision radar theodolite facility that had confirmed Yeager's climb to immortality. Welch's dives in the Sabre were measured during two flights on November 13. His first dive was clocked at Mach 1.02, the second at 1.04. The ba-booms were finally officially acknowledged, but only under tight security. The North American flight test reports are asterisked with a notation that data concerning speeds in excess of Mach 0.90 have been detailed in an amplifying document under higher security. This amplifying data could not be found in the North American archives. In Welch's handwritten flight log, these flights are variously classified as "Hi Mach No. Dive" or simply "Hi Mach." Between November 3, 1947, and the end of February 1948, Welch flew 23 flights in the XP-86 that are so characterized. Almost certainly each flight included at least one incursion into the realm of the supersonic. More likely two or three were made per flight. By way of comparison, during the same four-month period, the X-1 made seven flights, attaining supersonic speed on three of them, but no more than once per flight.



COURTESY GILES WELCH

George Welch's XP-86 logbook entries refer in shorthand to his sonic sorties, noted as "Hi Mach No. Dive" and "Mach No." Author Al Blackburn (below, readying for an F-100 flight) maintains that Welch could have gone supersonic two weeks before the X-1.

The Air Force's Wright Field XP-86 project officer, Major Ken Chilstrom, gave a glowing report on the aircraft while flying it to a maximum altitude of 45,000 feet and a Mach number of 0.90 during Phase II evaluation in early December 1947. Why didn't Chilstrom push the Sabre through the sound barrier? Probably because he was Colonel Boyd's chief of fighter test. Al Boyd kept a tight rein on Air Force flight test operations. He had just carefully nursed Yeager through Mach 1 after 28 flights spread over a year and a half. He no doubt had difficulty even conceiving that a prototype fighter only two months past its first flight could be ready to explore the supersonic realm. He was a great friend of Pancho's and had no doubt heard the rumors that floated out of her hacienda of Sabre ba-booms. But the fall of 1947 was an era in which the sonic boom phenomenon was not yet broadly understood, even by technically sophisticated people. Pancho had assembled some very nice young ladies, but none were CalTech graduates. Moreover, such knowledge as might have surfaced as a consequence of Yeager's flight was still highly classified. Similar restrictions were applied to details of the Sabre dances.

COURTESY AL BLACKBURN

Boyd was keenly aware of his route to stardom. He knew the X-1 program had special protection from high places. Being first to go supersonic was important to the Air Force. For the Bell Aircraft Company, it was absolutely vital. The X-1's sole purpose was to pave a way through the sound barrier. Millions of taxpayer dollars had been spent to make that happen. Now it had been done. For North American Aviation to come along and say "Hey, what's the big deal? Our new fighter does it as an incidental piece of cake" certainly wasn't going to be helpful. Boyd could see that

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After the Air Force tested three XF-86 prototypes, the fighter entered service as the Sabre in 1949 to face Soviet-designed MiG-15s in the Korean War. All the American aces of that conflict were F-86 pilots.

it was in the Air Force's best interests that the X-1 be clearly first by a considerable margin and that the Sabre rattling be quelled as long as it might take to keep the press away.

The Air Force wanted Yeager to push the mark a little higher. On November 6, Yeager raised the mark to Mach 1.35 at 48,600 feet. When the number two X-1 was ready for the NACA, the Langley leadership wanted to make sure one of their pilots—Herb Hoover—became the first civilian to crack the sound barrier. On March 10, 1948, Hoover flew the NACA X-1 to Mach 1.065. At that point, North American Aviation and the Air Force deemed it acceptable to announce that the Sabre had indeed gone supersonic as of April 26, a month and a half after Hoover managed to struggle through.

We know for certain that the number one XP-86 Sabre prototype did fly faster than the speed of sound, to Mach 1.02 and 1.04, as measured on the Muroc radar theodolite, on the two flights of November 13, 1947. Anecdotally, we know Welch was taking the Sabre supersonic as early as November 3, according to his logbook. But the reason for conducting those high-Mach exploratory flights in the first place was that Welch had complained to Ed Horkey about funny jumps in his airspeed indicator before any "Hi-Mach No." flights were scheduled. That would mean that on one or more of the Sabre flights in October, a supersonic excursion took place. For those who insist "Welch did it first," this would have had to have been on October 1, or on the fourth flight, prior to 10:30 a.m. Pacific time on October 14. Supporting the notion that Welch did in fact become the first Mach buster on October 1 is Jan Welch's call to her mother on October 10 or 11 to report the birth of a son on the 9th, and incidentally to announce the hush-hush fact that Welch had gone supersonic. Jimmy Williams, Jan's younger brother, remembered the call: His mother couldn't tell whether Jan was more pleased with the new baby or Welch's latest aerial exploit. Also attesting to the belief that Welch did it before Yeager are the affirmations of Bud Poage, Bob Cadick, Joe Swing, several of Pancho's girls, and scores of others.

Could anyone believe that in the supersonic sweepstakes a competent but wholly apolitical company could mount a meaningful challenge to the massively supported—both technically and politically—orange rocketship? What could be worse form than to rain on their parade, to cop their prize with a loud baboom, and then to shrug it all off as just another of the incidental challenges that must be met and mastered en route to building better fighters? For the truly dedicated, it's not so hard to say "Leave the laurels to those who need and want them most, we have a job to do," then laugh all the way to Pancho's to needle the old gal about betting on the wrong contender.

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DAN PATTERSON

>SIGHTINGS<

It's a given that most airplanes are beautiful. But rarely is the interior of an aircraft described that way. Still, the cockpits of vintage craft exude a peculiar charm of worn leather, scuffed metal, and scratched glass, damage gradually wrought by countless hands. In *Cockpit: An Illustrated History of World War II Aircraft Interiors* (Howell Press, 1998), photographer Dan Patterson writes, "The act of strapping in helps to integrate pilot and machine, and, ideally, the pilot's hands fall naturally to the stick and throttle…the machine responds, offering full three-dimensional freedom…and a level of exhilaration that is hard to match." The photograph at left of a Bristol Beaufighter is one of many portraits in Patterson's book.

National Air and Space Museum photographers Eric Long and Mark Avino captured in exquisite detail the cockpits of the B-29 *Enola Gay* (above) and the Hughes H-1 Racer (opposite). "With today's technology we can view cockpits from an extremely wide perspective," says Long. "Lost is the feeling of being cramped. The B-29 cockpit, for instance, gives the feeling of roominess. We use strobe lights for illumination, sometimes placing lights underneath seats. The resulting images offer a vantage point rarely, if ever, seen before."

Brushes with Space

NASA and the Exploration of Space, With Works from the NASA Art Collection *by Roger D. Launius and Bertram Ulrich, with a foreword by Senator John Glenn. Stewart, Tabori, and Chang, 1998. 224 pp., $60.00 (hardcover).*

NASA and the Exploration of Space is an eye-catching contribution to coffee table books on space. Roger Launius, NASA historian, and Bertram Ulrich, curator of the NASA art program, join talents to present a dual tale of space exploration and its representation in art. The art is the fresh and appealing center of their efforts. More than 175 works grace the book, all the fruits of a NASA program begun in 1962 to encourage painters and other artists to look at, document, and interpret the agency's charge to explore the heavens. The motivation for the book was to broadly sample the diverse NASA collection (much of which is housed at the National Air and Space Museum) and share it with the public.

The authors, though, make an odd choice in presenting this store of material. In energetic prose that draws on his deep understanding of space history, Launius tells the NASA story, ranging from pre-Sputnik days to work on the present-day space station to aspirations for the future—but surprisingly makes few or no references to the art itself. This well-told (and familiar) narrative seems a separate book.

Ulrich illustrates the history with a sampling of sketches, watercolors, oil and acrylic paintings, and other works that testify to the vigor and longevity of the art effort—each NASA program, from the heady days of Mercury, Gemini, and Apollo, through the shuttle, many of the science missions, and plans for the future, is represented. We find the work of the famous, such as Norman Rockwell and Robert Rauschenberg, as well as that of the less well known. The images offer a striking range of perspectives. Some capture an artist's experience as an intimate participant in readying astronauts for flight or in feeling the pulse of mission control. Others stand as interpretations of the cultural influences of space exploration or imagine the look and feel of future missions.

The book's overall effect is delightful, but you do wonder how this head and that hindquarters came together to form one creation. The authors miss the opportunity to tell the story of NASA's art collection, particularly its connections to the politics and cultural dimensions of space exploration.

Inaugurated by the savvy James E. Webb, NASA's second and perhaps most renowned administrator, the art program was part of his vision of the catalytic role the space agency could play in the nation's economic and social life. Webb used the clout of contract money to push industry and universities to take a more expansive view of their civic role in the Space Age. He wanted to stimulate the art community in a similar way, with the hope it could portray this grand adventure and integrate space exploration into the

nation's cultural experience. This attractive book gives us occasional tantalizing hints of this union of technology, politics, and the quirky world of art. Perhaps a future volume will marry these images with their history and help us understand the artists and their NASA sponsors.

—Martin Collins is a curator in the space history department of the National Air and Space Museum.

Night Fighter Ace *by Tony Spooner. Sutton Publishing (available from Books International in Herndon, Va., 703-661-1500), 1997. 176 pp., b&w photos, $33.95 (hardcover).*

The Royal Air Force's most highly decorated fighter pilot of World War II, Wing Commander John R. D. Braham is so little known that even Tony Spooner, an RAF squadron leader in the same war, did not hear of him until 1986.

That "Bob," a nickname picked out of a hat when there were too many Johns in No. 29 Squadron, is not better known is surprising, considering that his record of 29 confirmed kills was surpassed by the records of only four other RAF pilots. Braham was just behind "Screwball" Beurling (31.33 victories) and just ahead of "Sailor" Malan (28.66). Braham's victories were all achieved in twin-engine fighters, while the other leading RAF aces fought in single-engine aircraft. Group Captain John "Cat's-eyes" Cunningham became famous for destroying 19 German aircraft at night, precisely the number of Bob Braham's night victories.

While Cunningham, who went on to become de Havilland's chief test pilot, is still very much alive, Braham died in 1974 at age 53. For this biography, Spooner relied on Braham's many friends and family, plus two other main sources: an unpublished biography by a member of Braham's ground crew, and Braham's own autobiography, issued in the United States as *Night Fighter* by Norton in 1962, and as a Bantam paperback in 1984.

Like many of the aerial heroes of the second world war, Braham was young. He quit school at 16 and was commissioned in the RAF the following year. When the war began, he was a two-year RAF veteran at age 19. He made his 29th kill at age 24, with the rank of wing commander (equivalent to a lieutenant colonel), having already been a squadron commander at 22. But Braham had a slow start, partly because of bad equipment. His squadron was assigned to fight the Luftwaffe at night in slow Bristol Blenheims, without airborne radar. He didn't make his first kill until August 1940, when ground radar vectored him toward a Heinkel 111 caught in search lights. Like other young heroes, Braham fought hard and played hard, downing his share of alcohol and helping to trash his share of pubs and officers' messes. He married a young woman after a courtship of only 30 days, and he survived several crashes and close calls both during training and on operations.

It's hard to discern at what point Braham became more skilled/lucky/successful than his peers, but by mid-September 1941 he was an ace. By this time, No. 29 Squadron was flying all its operations in the big Bristol Beaufighter, which was 40 mph faster than the Blenheim, and equipped with intercept radar and heavier armament than any RAF fighter—four 20-mm cannon and six .30-caliber machine guns.

I believe that one secret of Braham's success was his choice of radio operator-navigators. Both Braham and author Spooner give credit to "Sticks" Gregory and "Jacko" Jacobs. Twenty-two of Bob's kills were made with Gregory or Jacobs' help. Five men helped him down another seven aircraft.

Spooner chronicles Braham's ever-more-successful career, narrating his

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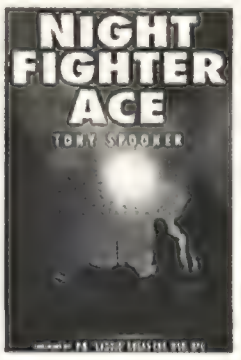
victories and listing the details in a table. There are three main periods in Braham's



war: First, he flew night fighter Beaufighters defending England in No. 29 Squadron. Then, as commander of No. 141 Squadron's Beaufighters, he led the development of "Serrate" tactics, hunting Luftwaffe night fighters within the RAF bomber streams over Europe. Finally, as a staff officer in the Second Group of the Tactical Air Force, Braham engaged in lone day missions over German-occupied Europe in de Havilland Mosquitoes. While his commander permitted these only once a week, on days when a low cloud cover (to hide in) was forecast, Braham and his navigator were eventually downed by a FW 190 on June 25, 1944, in Denmark. They were Luftwaffe pilot Robert Spreckels's 45th victory. Braham's autobiography reveals little about his 10 months as a guest in the Stalag Luft prison system, but Spooner's research adds some details.

I was glad that *Night Fighter* includes Braham's own description of his exploits because quite naturally, he writes a livelier tale than does Spooner, who is farther removed in time and person from the action. However, Spooner tells a good story too, and he has added a lot to periods that Braham glosses over, or couldn't know because he had not yet lived them. Spooner not only fills in some of the Stalag Luft blanks but also recounts Braham's second career in the Royal Canadian Air Force, during which he achieved the rank of group captain, and got a chance to meet his victorious opponent Spreckels again and buy him the scotch he promised when they met briefly in Germany in 1944.

—Sam Smith is a commercially licensed pilot and amateur aviation historian.

Blue Water Ops: On the Front Line of U.S. Naval Aviation *by Erik Hildebrandt. Howell Press, 1998. 128 pp., color photos, $39.95 (harcover).*

Frequent *Air & Space* contributor Erik Hildebrandt's first book is a compilation of some of his best work at sea—F-14 Tomcats and F/A-18 Hornets slamming aboard a carrier deck, deck handlers scrambling through catapult steam clouds, and crisp air-to-air photos.

We also get an insider's view of the grueling water survival training that all Naval airmen undergo. Hildebrandt underwent that training himself, so his photographs and text are particularly insightful. Hildebrandt describes in chilling detail what it's like to be strapped into the "helo dunker," a large fiberglass drum that simulates an aircraft fuselage. Trainees must exit the dunker, which rotates upside down after it is dropped into a swimming pool during four separate scenarios. On the fourth dunk, the trainees must exit the drum while wearing blacked-out goggles. The dunker earns its nickname, "panic in a can."

In addition to Hildebrandt's text, there are guest contributions, including an account by Lieutenant Rick Lucas, who describes what it's like to eject from a burning F-14 Tomcat.

Hildebrandt's photos take us onto the flight deck and place us among the deck handlers, plane captains, firefighters, catapult launch officers, and others who make carrier operations possible. Here the hazards are numerous—flailing arrester cables, hungry jet intakes waiting to suck in a careless crewman, and the dangers of working around aircraft loaded with jet fuel and explosives.

The photos catch some telling moments, like a landing signal officer with his left hand outstretched working imaginary throttles as he wills a fellow

aviator aboard. And there's a shot where the pride is evident on a sailor's face as he mans the rail in dress uniform while his carrier returns to port.

Blue Water Ops documents some unique happenings in naval aviation history. Airplane lovers will despair at Hildebrandt's photographs of Grumman A-6 Intruders being sunk off the Florida coast to make artificial reefs (see "Burial at Sea," December 1996/January 1997). And there are distinctive photographs that document the unprecedented launching of 12 World War II aircraft from the deck of the modern supercarrier USS *Carl Vinson* on August 29, 1995, to mark the 50th anniversary of the U.S. victory over Japan. Of particular interest was a North American B-25 Mitchell bomber that took off in commemoration of the Jimmy Doolittle-led raid on Tokyo in 1942. The carrier then sailed into Pearl Harbor, after the sailors lined the rails to salute the USS *Arizona* memorial.

Hildebrandt's book is a must for hook-and-wire fans.

—John Sotham is an associate editor at Air & Space.

One Pilot's Log *by Jerrold Sloniger. Howell Press, 1997. 256 pp., b&w photos, $34.95 (hardcover).*

Jerrold Sloniger has produced a wonderful coffee table-style book about his father, E.L. "Slonnie" Sloniger, who was one of the pioneers of passenger aviation and a leading character in Ernest Gann's classic memoir *Fate Is the Hunter.* The elder Sloniger never held a job outside aviation and became a long-serving chief pilot for American Airlines. He died in 1969 at age 73.

Sloniger's book, unlike many coffee table books, includes not only high-quality photographs but well-written as well. *One Pilot's Log* is, first and foremost, the biography of a talented pilot who flew during the formative years of commercial aviation. But the book is also lavishly illustrated with scores of rare and unusual photographs of early airliners, stunt aircraft, and open-cockpit mail transports.

Arranged like a logbook, with total hours tallied at the end of each chapter, the book relates Slonnie's fascinating aerial history. Slonnie earned his wings in the first world war and came home to barnstorm around the Midwest and Canada. His career brought him to Mexico, Peru, China, Japan, and Europe—virtually anywhere there was a runway.

Sloniger was one of the few early pilots who survived long enough—in both the financial and the mortal sense—to go from fighter pilot to barnstormer to passenger pilot. Crashes in those early days were commonplace. Pilot error, faulty equipment, and unpredictable weather were the early aviator's primary hazards. But Sloniger had the skills,

praised by none other than Charles Lindbergh, that allowed him to survive hundreds if not thousands of night runs as a mail pilot in all the unpredictable and nasty weather the Midwest can dish out.

He also survived the Depression, when passenger traffic virtually ceased and President Franklin Delano Roosevelt canceled the mail contracts, which were important subsidies for passenger travel. Further challenges came as the scores of small regional airlines consolidated into larger and larger companies, but despite these difficulties, Sloniger was appointed the chief pilot at the fast growing American Airways, later known as American Airlines.

During the second world war, Slonnie did a stint in the Air Transport Command, flying troops and supplies across the Atlantic, a job in which he often had to

work past the maximum hours allowed by regulations. After the war he returned to American, where air travel was beginning to become commonplace. He was there as American took the dominant position in U.S. passenger service.

Later, he walked away from that coveted position to help start an air passenger service for Matson Lines, a top-shelf Pacific cruise line.

After that venture failed, he took on a series of short-term freelance assignments. One day he told his wife, "I have decided to hang up my wings. I always told myself that when I could not do as good a job flying as I demanded of others, I would stop." And he did—cold.

Some 24,000 hours of flight time after he first set foot in a cockpit, Sloniger was finished. *One Pilot's Log* is a compelling tale that stretches from the earliest days of aviation and passenger travel into the Jet Age.

—Mark W. McKellar is a Massachusetts-based freelance writer who concentrates on aviation and naval history.

Wind: How the Flow of Air Has Shaped Life, Myth, and the Land *by Jan DeBlieu. Houghton Mifflin, 1998. 284 pp., $24.00 (hardcover).*

You might wonder how the seemingly simple topic of wind can provide enough material for an entire book, but through the pleasing and lyrical writing in *Wind*, we get more than we expect and a satisfying read.

Jan DeBlieu considers the effects of the everyday flow of Earth's atmosphere on animals, weather, and human activities. She also considers the role that religion has played in our understanding of wind—some believe that wind is the divine breath of life from God. Such beliefs, rooted both in mythology and popular religious dogma, are inspired by the way Earth's moving currents of air shape our landscape and nurture plant life by pollinating flowers. But the forces of wind can also destroy—DeBlieu vividly describes the devastation wrought by Hurricane Andrew, as well as the small-scale destruction of plant stems and leaves caused by wind and blowing ocean spray.

Passionately written, DeBlieu's *Wind* explores a meteorological topic with a poet's touch.

—Karen A. Sager was an American Society of Magazine Editors intern at Air & Space.

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CREDITS

Squeeze Play. O.H. Billmann says he lives the life of a recluse in Simi Valley, California, recalling stories from his 46 years in aviation at the drop of a hat—which explains why he is a recluse.

The Count's Flying Houseboat. In addition to writing suspense novels, William Hallstead, a former flight instructor, also writes about aviation.

Inventing the Spyplane: That New Black Magic. William E. Burrows is the author of *This New Ocean: The Story of the First Space Age* (Random House, 1998).

Further reading: *The CIA and the U-2 Program, 1954–1974*, G. Pedlow and D. Welzenbach, CIA, 1998; order via e-mail at orders@ntis.fedworld.gov.

The Ultralight Tribe. Tim Wright's photography appears regularly in *Air & Space/Smithsonian*. This is his first piece of reporting for the magazine.

Allie's Choice. Writer Nancy Allison Wright specializes in aviation history.

Birth of a Station. Nashville, Tennessee-based illustrator Harry Whitver has drawn hundreds of airplanes during his career.

Understudy. Carl Posey wrote a history of the doomed Manned Orbiting Laboratory for the June/July 1998 issue.

Mark Finkenstaedt knows runways—fashion runways, that is, from London to New York. For the past five years, he has photographed a wide range of subjects in and around Washington, D.C.

FrigidAir. Joseph Bourque is currently pleading for an assignment in the tropics.

Minnesota-based photographer Erik Hildebrandt already owned all the long underwear required to withstand the –40 degree temperatures he encountered in the Arctic. His cameras, on the other hand, needed some special attention to keep from freezing up.

Saint Yuri. Tom Harpole has traveled to Russia five times for *Air & Space*. He thinks he understands Russian.

Mach Match. Al Blackburn was the subject of "Runways of Fire" (Oct./Nov. 1995) and the author of a Commentary, "GPS, Inc." (Dec. 1997/Jan. 1998).

A New Life for an Old Field. New York City-based writer Phil Scott is a frequent contributor.

CALENDAR

December 5 & 19
U.S. Air Force Heritage Tour: an overview of the history of U.S. air power from 1907 to the present. U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704.

December 7
Opening of "Road to War in the Pacific," an exhibit that runs through November 1, 1999. A P-40 Warhawk will do a flyby. Palm Springs Air Museum, Palm Springs, CA, (760) 778-6262, ext. 223.

December 13
Geminids meteor shower. The waning crescent moon rises shortly before sunrise, which should allow several hours of good viewing.*

December 19
"The Wright Brothers," a family program for parents and elementary schoolchildren. Learning Center, U.S. Air Force Museum, Wright-Patterson Air Force Base, OH, (937) 255-4704.

U.S. Marine Corps Weekend. Flight demonstrations of several aircraft, including an AV-8B Harrier, a CH-46 Seaknight helicopter, and an AH-1 or AH-64 attack helicopter. Palm Springs Air Museum, Palm Springs, CA, (760) 778-6262, ext. 223.

January 1
Sno'Fly: The First Kite Fly of the Year. Kite-making workshops for participants of all ages. Prizes will be awarded for Awesomest Earmuffs and Best Decorated Sled. Prairie View County Park, Kalamazoo County, MI, (616) 383-8778.

**Call the Smithsonian's Earth and Space Report at (202) 357-2000 for recorded information on astronomical events.*

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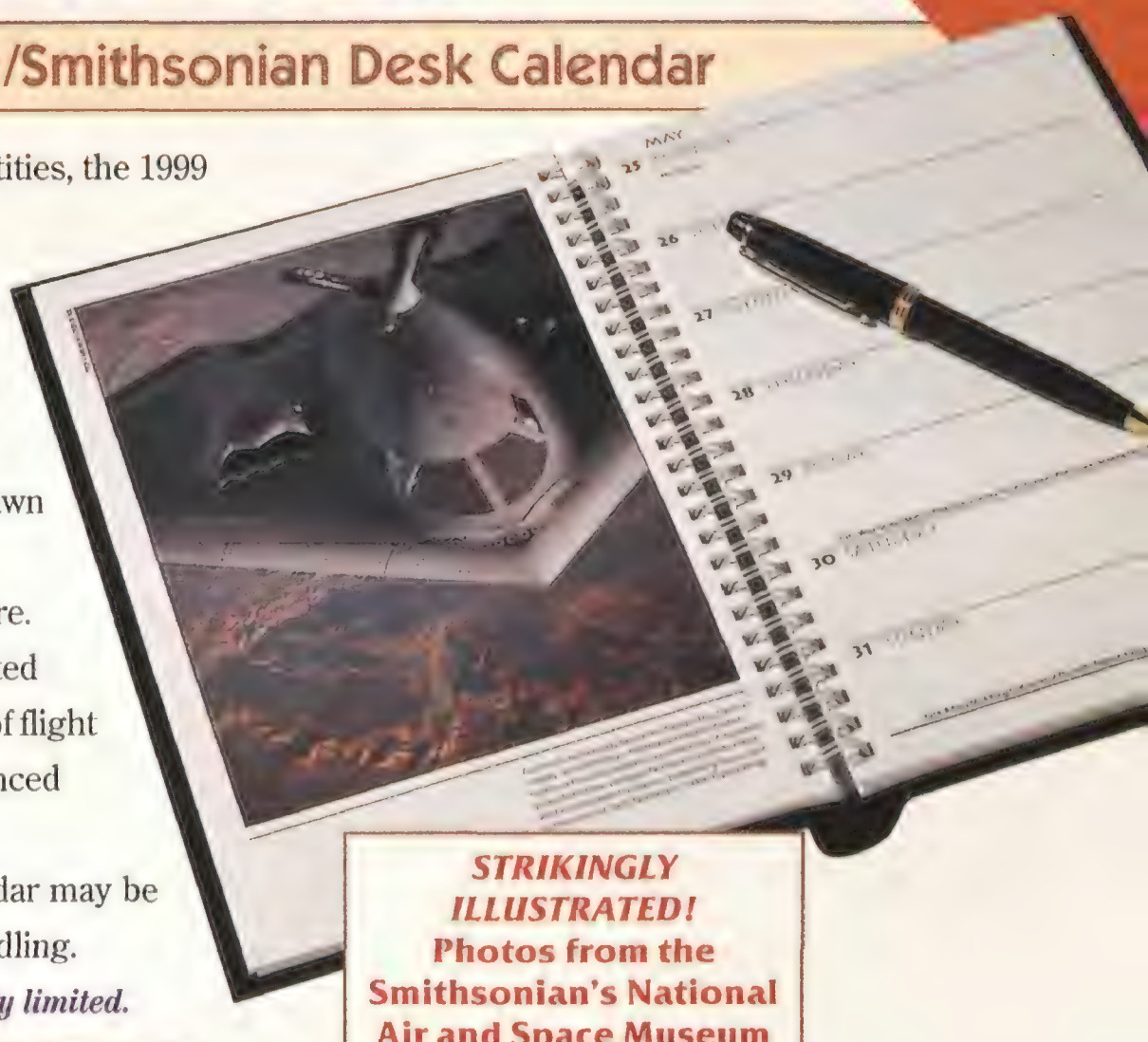

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Just in case you missed any part of the long-running *Air & Space/Smithsonian* series on the air war in Vietnam, you can find the first installments on the Web. Stories about famous men and famous missions, harrowing rescues, and narrow escapes appear at **www.airspacemag.com/ASM/mag/series/Vietnam.html**

FORECAST

In the Wings...


BRAD TRENT

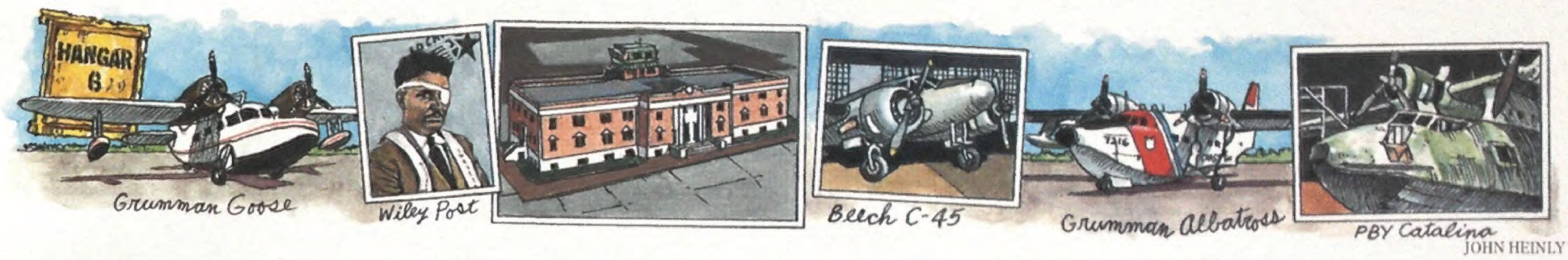
The Sixth Annual World Hot Air Airship Championships
Proving that if it flies, there will be an international contest to see who flies it best.

SuperHog
It may be one ugly critter, but during Desert Storm the A-10 "Warthog" demonstrated the beauty of adaptability and escaped decommissioning in the process.

Dangerous Debris
The U.S. Air Force Space Command has a plan to spruce up low Earth orbit.

High Society
The Aviation Country Club of Long Island had 100 acres of grassy landing field, a membership including Charles Lindbergh and Cornelius Vanderbilt Whitney, and an attitude: The best flying is done by the best people.

Flying in the Blood
Our cutting-edge genetic research shows that flying may run in the family. (Or may not.)



JOHN HEINLY

Floyd Bennett Field Trip

The first time I laid eyes on Long Island's Floyd Bennett Field, I recognized the place instantly: In many photos from aviation's Golden Age, the field serves as the background—tan brick, white frieze, and winged globe reliefs, all set amid great expanses of sun-bleached concrete. Today, the formal lawn has been paved, a parking lot has been put in, and scores of glass panes in the hangars have fallen to the aim of vandals, but otherwise much remains the same—not only the terminal building but also eight hangars, all of it an odd, pleasing blend of Federalist and Art Deco styles. And now a group of volunteers is working to bring back more of the beautiful old field's historic charm.

Named after a New York pilot who flew for polar explorer Richard Byrd, the airport was completed in 1931 and dedicated to commercial aviation. Some of the most important American long-distance flights either began or ended on this field or in the immediate area (see "The Rise and Fall of Floyd Bennett Field," June/July 1987). The first flight across the United States started out from nearby Sheepshead Bay, when Cal Rodgers took off in the *Vin Fiz* in 1911. The first aircraft crossing of the Atlantic got its start even closer in, with U.S. Navy Lieutenant Commander Albert Read flying the Curtiss NC-4 from Jamaica Bay in 1919. Wiley Post's 1933 circumnavigation in the *Winnie Mae* ended here, as did Howard Hughes' record-setting three-day round-the-world 1938 flight in a Lockheed Super Electra. And the same year, Douglas Corrigan set out from the field for California (or so he claimed) but ended up in Ireland, earning the nickname Wrong Way.

Preparing for the U.S. involvement in World War II, the Navy bought Floyd Bennett Field in 1940 and operated anti-submarine, training, and aircraft ferrying squadrons there. When the service vacated it 30 years later, no other organization stepped in to use the field, though the Coast Guard and a few other organizations used some of the facilities. In 1979 the National Park Service drafted a plan to preserve Floyd Bennett Field. "It's probably the most complete extant airport from the 1930s," says Roger Scott, a public affairs specialist for the sprawling Gateway National Recreation Area, of which the 400-acre field is a small part.

Crews arrested the decay in the old control tower and started restoring the dark, austere two-story rotunda and all of the elegant details: marble steps, oak doors, banisters with intricate metal railings, and a stained glass skylight depicting a dove. It's hard to believe that this space, the approximate cubic footage of Thoreau's shack at Walden Pond, was once the waiting room and lobby for one of the biggest, busiest airports in the United States.

Floyd Bennett Field, Jamaica Bay, Brooklyn, NY 11234. Phone (718) 338-3799. Open every day 8:30 a.m.–5 p.m. Admission free.

The basement of the terminal, still unrestored, once held a bar, a barbershop, and a post office and had tunnels leading out to the field so that aircraft could take on passengers and cargo in foul weather. The second floor, still under restoration, had rooms where pilots passing through could spend the night. And up a steep, narrow staircase is the control tower, a squat glass house that surveys the field's runways, which have barely changed since the 1930s. Though no air traffic control equipment remains in the tower, visitors can get an excellent view of the Manhattan skyline.

Outside, between the terminal and original hangars, sits a charmless blue hangar, erected in the late 1950s. During the resuscitation of the field, a group of volunteers, dubbing themselves HARP, for Historic Aircraft Restoration Projects, set about restoring the power and plumbing to the structure so that it could be used to exhibit various aviation artifacts. Today, visitors can examine a range of powerplants there: a World War I-era 100-horsepower Gnome rotary; a rare 270-hp Liberty V-8; and two Pratt & Whitney engines: an R-1830 Twin Wasp and an R-2800 Double Wasp. As for the aircraft at the field, the majority are naval. Most immaculate is a privately owned Douglas C-54 transport, christened the *Spirit of Freedom*, that served in the Berlin Airlift and is stabled at the field in the winter. There's also a U.S. Coast Guard HH-3F Pelican search-and-rescue helicopter; two Grumman amphibians, a Goose and an Albatross; and a jaunty Beech C-45 Navigator, looking as though it awaits an aviator with a leather helmet and jodhpurs to board it for a long-distance record attempt.

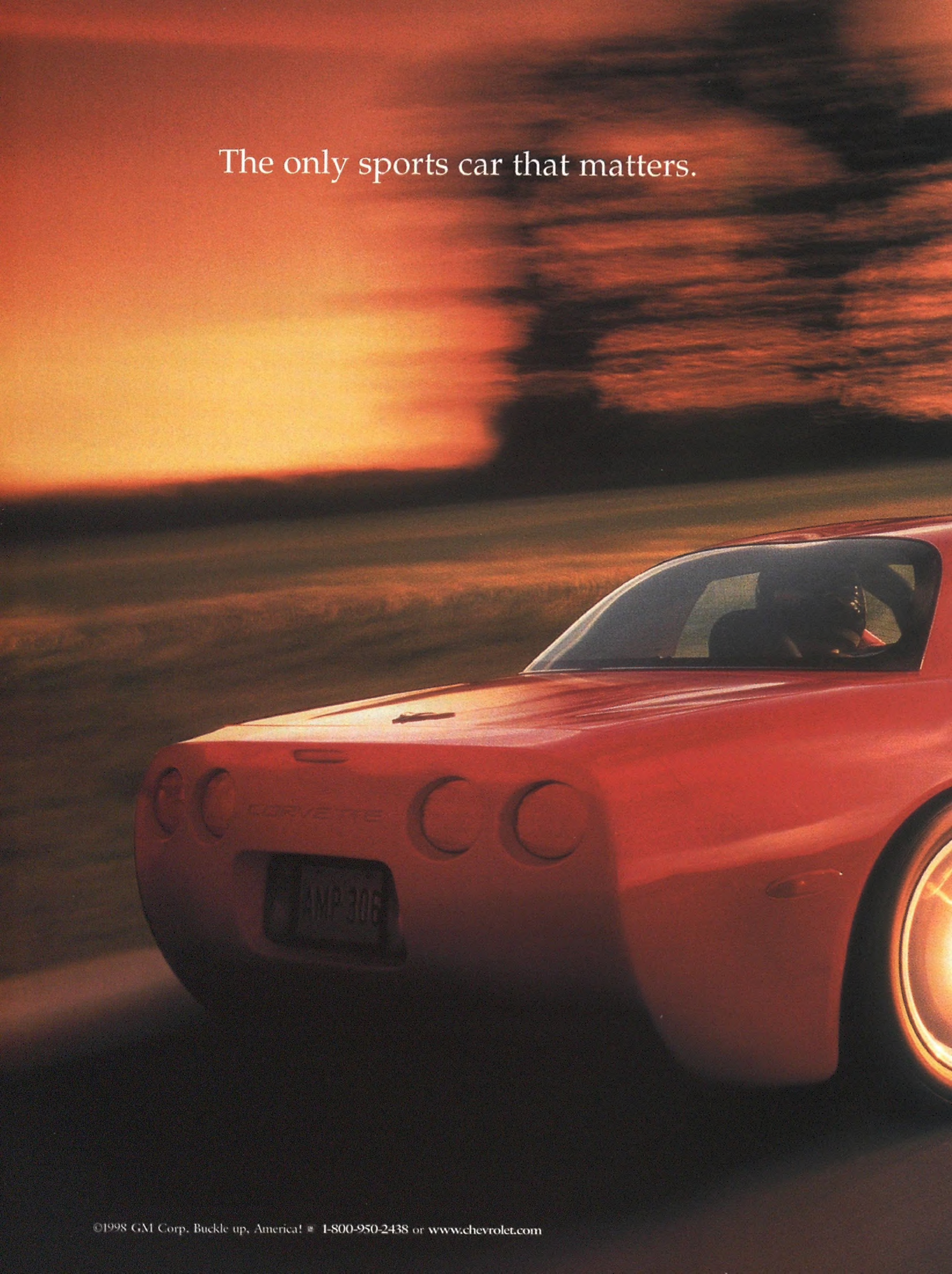
Some of the aircraft at the field have needed restoration help from HARP. Undergoing a facelift is a cold war-era Douglas A-4 Skyhawk attack-bomber, its wings laying off to the side on sawhorses. And stripped of its control surfaces and paint is a PBY-5 Catalina amphibian, the museum's most complex aircraft restoration project.

The restorers' leader, Arnie Migliaccio ("Mig," as he is known around the shop), notes that his volunteers currently number around 45. "Most are retirees," he says. "We got electricians and carpenters, mechanics, and general help—I'll ask them to do any function on any aircraft and they do it." Often they count among their number students from nearby Aviation High School, who come to learn such arts as re-covering fabric control surfaces.

The volunteers are now moving the museum out of the blue building and into some of the field's original hangars, which have more character. As for other plans, HARP would like to finish renovating the main building and establish a proper visitors' center.

Still, Floyd Bennett Field is worth seeing now. And being about as solidly built as the average Egyptian pyramid, it will doubtless be there for future generations to admire.

—Phil Scott



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